The Western Australian species of subtribe Persooniinae (Proteaceae: Persoonioideae: Persoonieae)

Peter H. Weston

Abstract

Weston, Peter H. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney NSW 2000, Australia) 1994. The Western Australian species of subtribe Persooniinae (Proteaceae: Persoonioideae: Persoonieae). Telopea *6(1): 51–165.* The Western Australian species of subtribe Persooniinae (Proteaceae: Persoonioideae: Persoonicae) are revised. The history of taxonomic work on the Persooniinae is reviewed and evidence for the monophyly of the subtribe evaluated. The balance of evidence supports the monophyly of the Persooniinae but not the generic level classification proposed by Johnson & Briggs. The generic classification presented here recognises three monotypic genera, *Garnieria*, *Toronia*, and *Acidonia*, and the large genus *Persoonia*. Morphological terminology used in the descriptions is reviewed and defined. A key and descriptions of all 43 species are presented. Seventeen new species are described: **Persoonia baeckeoides, P. biglandulosa, P. bowgada, P. brevirhachis, P. chapmaniana, P. cordifolia, P. cymbifolia, P. filiformis, P. helix, P. hexagona, P. inconspicua, P. kararae, P. micranthera, P. papillosa, P. pentasticha, P. pertinax, P. stricta.**

Introduction

The subtribe Persooniinae (Proteaceae: Persoonioideae: Persoonieae) is a taxon of about 100 species, all but two of which are endemic in Australia. *Toronia toru* (Cunn.) L.A.S. Johnson & B.G. Briggs is endemic in New Zealand (see Allan 1961, Johnson & Briggs 1975) and *Garnieria spathulifolia* (Brongn. & Gris) Brongn. & Gris in New Caledonia (Virot 1968). This paper is a revison of the Western Australian species of the subtribe, which constitute a heterogeneous assemblage, defined purely on a geopolitical basis. Nevertheless, only one Western Australian species, *Persoonia falcata*, occurs outside the State, so it is a convenient 'group' for species-level revision. Abbreviated treatments of all species of *Persoonia* will be provided in the forthcoming volume 16 of the *Flora of Australia*. Revision of the higher-level classification of the Persooniinae necessarily involves cladistic analysis of the relationships of all species. I have completed an unpublished cladistic analysis of the subtribe (Weston 1983) and an updated version of that analysis will be published separately. However, since the generic circumscription used herein is novel, higher-level relationships are discussed briefly below.

Taxonomic history of the Persooniinae

Monophyly and relationships of the Persooniinae

The subtribe Persooniinae is a relatively new addition to the infrafamilial classification of the Proteaceae, having been erected by Johnson & Briggs (1975) in the most recent review of relationships within the family. These authors grouped the Persooniinae with *Placospermum* in the tribe Persoonieae, which in turn is grouped with *Bellendena*

to form the subfamily Persoonioideae, one of five in their classification of the Proteaceae.

Johnson & Briggs (1975) cited the following character states as putative synapomorphies for the Persooniinae: (1) drupaceous fruits, (2) wingless seeds, (3) F2 leaf phase (compound or lobed leaves) absent, i.e. leaves exclusively simple and entire. Further, the synapomorphy grouping the Persooniinae with *Placospermum* (thus circumscribing the tribe Persoonieae) is (4) unusually large (15–30 µm) chromosomes; they also share a chromosome base number of x = 7 but Johnson & Briggs consider this similarity to be a symplesiomorphy. Of these four character states, only (4) has not been derived convergently within the family according to Johnson & Briggs' phylogenetic hypothesis. Of the other three character states, (1) offers the strongest evidence in favour of the monophyly of the Persooniinae but even drupaceous fruits must have evolved independently, in at least one other lineage, in the Cenarrheninae of the subfamily Proteoideae, according to Johnson & Briggs's classification. Character state (2) must have at least three separate origins in the Proteaceae. Character state (3) seems the least reliable, F2 leaves having been lost repeatedly in numerous taxa in the family.

Johnson & Briggs (1975) cited discussion in their earlier paper (Johnson & Briggs 1963) justifying their postulated homologies and character polarities. In neither paper did they state explicitly the criteria that they used to determine character state polarity but in many cases outgroup comparisons were implied. However, some authors, most notably Venkata Rao (1971), White (1978) and James (1981), disputed their proposed polarities.

All three authors disagreed with Johnson & Briggs' postulated cytoevolutionary trends. Venkata Rao (1971), for example, considered the primitive genome to have consisted of five medium-sized chromosomes as is found today only in *Bellendena*. However, his arguments in its favour are illogical: since *Bellendena* is the 'most primitive' member of the family it therefore should retain a primitive karyotype. The assumption that some extant taxon must have retained all of the primitive features is fallacious (see e.g. Stevens 1980). Nevertheless, Venkata Rao's hypothesis is also consistent with a sister group relationship between the Persooniinae and *Placospermum*.

White (1978) and James (1981) proposed a radically different cytoevolutionary hypothesis: they argued that the plesiomorphous karyotype consists of fourteen small chromosomes and that all of the lower chromosome numbers have resulted from dysploid decreases in number. Neither of these authors based his argument on outgroup comparisons but rather on assumptions of the nature of cytoevolutionary processes. James, for example, regarded dysploid decrease in chromosome number, brought about by chromosome fusions and resulting in increased chromosome size, to be more likely than either dysploid increase or polyploidy. However, I reject this approach to the study of evolutionary patterns and instead agree with Eldredge & Cracraft (1980) that evolutionary patterns should be used to formulate and test theories of evolutionary process rather than vice versa. Consequently, I see no reason to adopt White's and James' cytoevolutionary hypothesis *a priori*.

Johnson & Briggs (1975) claimed that their cytoevolutionary theory is supported by 'the comparative and correlative evidence' which presumably means a combination of outgroup and functional outgroup methods of character analysis (Watrous & Wheeler 1981). They cited a number of authors in favour of the hypothesis that a haploid number of $n = 7$ is primitive for angiosperms and by implication, for the Proteaceae. They also pointed out that extremely large chromosomes such as are found in the Persooniinae and *Placospermum* are exceptional among woody

angiosperms. That is, outgroup evidence suggests that large chromosomes are apomorphous within the Proteaceae.

Venkata Rao (1971) maintained, contrary to Johnson & Briggs (1963), that drupes or drupaceous nuts with wingless seeds are primitive in the Proteaceae. He based this conclusion on a supposed correlation of (primitive) rainforest habitat with drupaceous fruits. This argument is spurious for two reasons: firstly, as discussed above, 'correlative evidence' of this type is not a valid form of character analysis; secondly, as Johnson & Briggs (1975) showed, there is just as much 'correlative evidence' for the primitiveness of follicles as there is for drupes. Johnson & Briggs (1975) defended their position, arguing that indehiscent fruits within the Proteaceae are quite heterogeneous in structure when compared with the range of variation of dehiscent fruits in the family. Indehiscent fruits are therefore more likely to be non-homologous with one another than are the different follicular fruits. Consequently it seems more parsimonious to regard the sporadic occurrence of dehiscent fruits throughout the family as the result of plesiomorphy rather than multiple origin. Presumably this is what Johnson & Briggs (1975: 111) meant when they stated that there is 'abundant correlative evidence in the Proteaceae for the primitiveness of follicles.'

On the basis of the few relevant morphological and karyological characters available, it seems reasonable to retain both the subtribe Persooniinae and the tribe Persoonieae as putatively monophyletic taxa. The monophyly of the Persooniinae is also weakly corroborated by Martin & Dowd's (1988) analysis of *rbc*S amino acid sequences in a small sample of proteaceous taxa. *Toronia torn* and *Persoonia chamaepeuce* were the only two species of Persooniinae included in their analysis and they constitute a cluster in their cladogram.

Generic and infrageneric classification of the Persooniinae

The first species to be described in the Persooniinae was the south-eastern Australian *Linkia levis* by Cavanilles (1797). A year later, J.E. Smith provided a description of the new genus *Persoonia*, without describing any species (Smith 1798), but it was not until 1799 that the first *Persoonia* species, *P. lanceolata* and *P. linearis* were described (Andrews 1799). Since then, it has been generally accepted that *P. lanceolata*, *P. linearis* and *L. levis* are congeneric. *Persoonia* became the widely used generic name, challenged subsequently only by Kuntze (1891). *Persoonia* was formally conserved against *Linkia* in Briquet (1935). In describing *Persoonia*, Smith (1798) placed the genus in Linnaeus' artificial class Tetrandria: Monogynia and, although he assigned a number of other genera to the Proteaceae in the same paper, he considered *Persoonia* to be most closely related to *Loranthus*.

By 1810 when Robert Brown produced his monograph of the Proteaceae (Brown 1810a) it was generally accepted among taxonomists that 'natural groups' of organisms exist and that the task of systematists was to recognise such groups and to embody them in 'natural classifications' (Stevens 1984). Brown fervently agreed with this principle and attempted to produce a natural classification of the Proteaceae (Mabberley 1985). He divided the family into two subfamilies, the Proteoideae and Grevilleoideae, placing *Persoonia* in the former subfamily. He did not, however, erect an infrageneric classification for *Persoonia*.

The first infrageneric classification of *Persoonia* was proposed by Meisner (1856). He divided the genus into two sections, *Leptostylis*, which included all of the species with exserted gynoecia, and *Pycnostylis*, which included the irregular-flowered, hooked-styled species as well as the short-styled *T. torn*. He further divided each section into two series on the basis of whether they possess anther appendages or not.

Although the Darwinian revolution was well under way by the time Bentham (1870) produced his infrageneric classification, systematic methods remained essentially the same as in Meisner's day. Although natural classifications were now seen as reflecting evolutionary relationships, no new systematic methods had been deduced from the new evolutionary theory (see e.g. Stevens 1984). Bentham grouped the Australian species into three sections, corresponding exactly to three of Meisner's series (the fourth being *P. toru*, i.e. *Toronia toru*, the New Zealand species). Once again, no other characters or combinations of characters were used to describe the sections beyond the style and anther characters used by Meisner. The defining characters of the sections were used to form the primary leads in his key to *Persoonia* species.

The next genus in the Persooniinae to be published was *Garnieria* by Brongniart & Gris (1871). These authors had earlier described the single species as *Cenarrhenes spathulifolia* (Brongniart & Gris 1865) but decided that since it possesses numerous ovules in contrast to all other indehiscent-fruited Proteaceae, it should be placed in a genus of its own. Although all subsequent authors have placed *Garnieria* and *Persoonia* in the same subfamily, it was not until Johnson & Briggs (1963) that they were recognised as being each other's closest relatives.

In the same paper, Johnson & Briggs suggested that *Persoonia* be split into four genera corresponding to Meisner's series:

> *Persoonia*, as at present defined, comprises four groups. Though all are manifestly related, they do not seem any closer to each other than one of them (*P. toru*) is to *Garnieria*, and some readjustment of generic limits is probably desirable. (Johnson & Briggs 1963: 36).

In their 1975 paper, these authors followed up their earlier comments by formally elevating Meisner's series to the rank of genus:

> ... from the present analysis we conclude that *Persoonia* sensu lato should be divided into four genera, as foreshadowed in our earlier study. These are *Persoonia* Sm. sensu stricto, chiefly in E. Australia but with five species in S.W. Australia; *Toronia* (*Persoonia toru* A. Cunn.) in New Zealand; *Acidonia* (*Persoonia* sect. *Acranthera* Benth.) endemic in S.W. Australia; and *Pycnonia* (Persoonia sect. *Pycnostylis* Meisn.), with short styles and zygomorphic flowers, chiefly in S.W. Australia but with one species ranging across northern Australia. They are as distinct from each other as any of them is from the monotypic *Garnieria* Brongn. & Gris of New Caledonia and stand co-equally with it to constitute the well defined subtribe Persooniinae. (Johnson & Briggs 1975: 99).

Of the five genera that Johnson & Briggs (1975) recognised in the Persooniinae, neither *Persoonia* nor *Acidonia* possesses postulated synapomorphies. Johnson & Briggs justify this part of their classification on phenetic rather than cladistic grounds, referring to the 'distinctness' of groups. Such reasoning would be acceptable under a gradistic approach to classification but is clearly inappropriate within a cladistic framework.

My earlier cladistic analysis of the Persooniinae (Weston 1983) resulted in the conclusion that neither *Persoonia* nor *Acidonia* is monophyletic as circumscribed by Johnson & Briggs (1975). That analysis was conducted using computer software that is primitive by today's standards, and character recoding and reanalysis is now necessary before publication. Nevertheless, some of my conclusions were strongly supported and are most unlikely to be overturned by a new analysis. In particular, *Acidonia* is most unlikely to be corroborated as a natural group. Interestingly, however, the type species of *Acidonia*, *A. microcarpa*, clearly belongs to a basal lineage

in the Persooniinae. Whether it turns out to be sister species to the rest of the Australian species of Persooniinae (Weston 1983) or to *Garnieria* plus *Toronia* now seems unclear. Either way, its segregation from *Persoonia* (sens. lat.) as a monotypic genus would not render the latter paraphyletic, while its retention in *Persoonia* might. Johnson & Briggs' genus *Pycnonia*, on the other hand, is a strongly corroborated clade, but its segregation would render *Persoonia* paraphyletic. *Pycnonia* seems to be most closely related to the group of species that make up the bulk of Johnson & Briggs' concept of *Acidonia* (*Persoonia trinervis* to *P. filiformis* in my treatment, below). Given these considerations, it seems wisest to treat *Acidonia* as a monotypic genus and not to recognise the genus *Pycnonia*. Johnson (pers. comm.) now agrees with the phylogenetic implications of this classification, although he would not necessarily adopt as broad a circumscription for *Persoonia* as here adopted. My classification of the subtribe is as follows.

Subtribe Persooniinae

Garnieria (*G. spathulifolia*, New Caledonia)

Toronia (*T. toru*, New Zealand)

Acidonia (*A. microcarpa*, Western Australia)

Persoonia (c. 98 species, Australia)

Classification in the Persooniinae at the species level

The majority of *Persoonia* species now known were described during the nineteenth century. Until 1810, only a handful of species had been described and of these, all but one, *P. juniperina* Labill. (from Tasmania), had been collected in the Sydney area. The botanical exploration of Australia was in its infancy at this stage but it was given a great boost by Brown's around-Australia voyage with the explorer Matthew Flinders between 1801 and 1803. Brown described many new species in the Proteaceae based on specimens collected on this trip and published them in his monograph on the family (Brown 1810a). He described 22 species of *Persoonia* in this work, including sixteen new to science. This treatment could be regarded as the first taxonomic revision of *Persoonia* although the descriptions that he provided were only brief.

New species were described in a piecemeal fashion over the next 45 years. The most significant contributions came from Robert Brown and F.W. Sieber. Brown (1830) described three new species from Western Australia and 16 from south-eastern Australia, six of them collected by Allan Cunningham. Sieber (1825) collected and informally named seven new species from south-eastern Australia and these were formally named and described by Sprengel (1827) and by Schultes & Schultes (1827).

The next complete treatment of the genus was provided by Meisner (1856), who provided detailed descriptions of all of the species known at the time. He described 10 new species in this work but had already described 6 others (Meisner 1855). All of the 12 new Western Australian species were based on the collections of James Drummond.

Bentham (1870) provided a new treatment of *Persoonia* in Australia with detailed descriptions of all species, and incorporating Mueller's (1868) two new species. This was the most critical work so far produced on the genus: although Bentham described two new species, he also reduced a number of others accepted by Meisner to synonymy and corrected some nomenclatural errors that Meisner had made.

Between 1870 and the early 1950s all work at the species level in the subtribe was of a piecemeal nature. Miscellaneous new species were described by Mueller (1876), Moore (1899), Fitzgerald (1912), Gandoger (1919), Domin (1921), and Audas & Morris (1929). Of these contributions, that of Gandoger (1919) demands the most attention. He described fifteen new species from south-eastern Australia, all but one of which seem to be conspecific with previously described species. Stafleu & Cowan (1976: 909) describe Gandoger as 'one of the greatest splitters ever' and it is easy to see how he earned this title. For example, he created two new synonyms for *P. pinifolia* R.Br., a distinctive and comparatively invariable species. Interestingly, his herbarium includes specimens of a number of species that were still unnamed.

In the early 1950s, L.A.S. Johnson critically revised the south-eastern Australian species of *Persoonia* and produced a typescript of his treatment. Soon, two of his new species, *P. silvatica* and *P. subvelutina*, were named (Johnson 1956) but the bulk of his treatment remained unpublished. A revised version of Johnson's treatment of the species from New South Wales was recently published by Krauss & Johnson (1991), Weston & Johnson (1991) and Weston (1991).

Orchard (1983) revised the taxonomy of the Tasmanian species, naming the one new species and resurrecting another name from obscurity. While his treatment of the three endemic species samples variation across the distributions of those taxa, his treatment of *Persoonia juniperina*, a species that also occurs extensively on the Australian mainland, is incomplete.

The taxonomy of *Toronia toru* has not been revised since it was described originally by Cunningham (1836) but there can be no question of the specific status of this distinctive plant. Allan (1961) provides a recent and reasonably detailed description of this species (as *Persoonia toru*). Virot's monographic treatment of the New Caledonian Proteaceae (Virot 1968) provides a critical review and a detailed description of *Garnieria spathulifolia*.

By 1980, the only members of the Persooniinae that had been spared any form of broad-scale systematic attention since Bentham (1870) were the south-western Australian species. To this 'group' may be added the northern Australian *Persoonia falcata* which has been included in three Flora treatments this century, none of which involved examination of specimens sampled across its broad geographic range. Many specimens have been collected and many new areas explored since Bentham's time, rendering his species level classification out of date. I revised the Western Australian species of Persooniinae as part of my Ph.D. thesis (Weston 1983) and a revised and updated version of that treatment is published here.

Materials and methods

Although I have reviewed the descriptive literature on the Persooniinae as a useful source of ideas, I have not relied on this source to a great extent in collecting data. The information presented here is based primarily on my own observations of herbarium specimens and cultivated plants as well as on field studies. I have seen all species in the field except P. *cordifolia*, *P. flexifolia*, *P. kararae*, *P. leucopogon*, *P. papillosa*, *P. pentasticha*, *P. pertinax*, *P. rudis*, and *P. spathulata*. The collector's notes on herbarium sheet labels were used to supplement my own observations of habit and flower colour. One or more flowers of each species (and for some species, a flower from each specimen examined) was reconstituted using a weak detergent solution, and dissected. Live flowers were dissected when available.

Cross-sectional shape and gross anatomy of leaves was studied by sectioning them. Where available, fresh leaves were collected from cultivated plants, but otherwise preserved leaves were used (leaves fixed in formalin-acetic acid-alcohol (FAA) or leaves from dried herbarium specimens reconstituted using a weak detergent solution). Transverse leaf sections were cut by hand with a razorblade, stained in toluidine blue and mounted in Gurr's water mounting medium. Map diagrams of the leaf preparations were drawn using a camera lucida.

Cross-sectional shape of floral organs was examined by making transverse serial sections of flower buds, anthers and flowers at anthesis. Fresh and dried material was used. Fresh material was fixed in either FAA or glacial acetic acid. Dried flower buds were either (i) soaked in concentrated ammonia overnight, then rinsed in running tap water overnight and stored in FAA or (ii) soaked in distilled water for a day, boiled in 2% KOH solution for 3–5 minutes, then rinsed in running tap water overnight and stored in FAA. Specimens were dehydrated, cleared and embedded in wax, cut at 10–15 µm and stained with crystal violet and erythrosin.

Embryo anatomy was studied by making transverse serial sections of freshly excised embryos. Pyrenes were cut out of drupes, carefully cracked in a vice and the embryos removed. These were fixed in FAA overnight, dehydrated, cleared and embedded in wax, cut at 10-15 µm and stained with either safranin and fast green or crystal violet and erythrosin.

Morphology, descriptive terminology

Habit

The habit of *Persoonia* species varies in several characteristics including the above-ground branching pattern, underground morphology, the orientation of the stems (i.e., whether the plant is erect, decumbent or prostrate), plant height and breadth, density of branches and foliage, thickness of stems, and bark-type. Less information is generally available for most habit characters than for morphological characters and consequently they may be less reliable for identification purposes. Some habit variables are disregarded because of the difficulty in establishing meaningful units for interspecific comparisons (e.g., density of branches and foliage, plant breadth). Other characters such as basal stem thickness are disregarded because of lack of data. Despite these problems, some habit characters were found to be useful in diagnosing taxa and therefore are included in the species descriptions.

The species are mostly shrubs (less than 4 m high) or small trees (more than 4 m high). Only one species, *P. graminea*, is known to flower while still appearing herbaceous but usually even it is found as a larger, woody, though weak-stemmed shrub. The known range of variation in mature plant height is given in each description.

Three different (though not distinct) above-ground branching patterns are distinguished. In some plants the primary branching occurs underground so that several to many stems arise independently, forming a clump of shoots. In the second type there is a single basal stem that branches just above ground level so that the plant is a rounded or spreading shrub if it is erect. The third type has a single basal stem that does not branch until well above ground level. Such plants have a distinct crown or canopy if erect. There is no clear-cut distinction between these three types, although some species exhibit one type exclusively. For example, *P. longifolia* usually produces a single main trunk with a canopy but there may be many short shoots clustered at the base of the trunk. When the underground

morphology of plants is considered, a more complex classification is required. The simplest class is stenobasic architecture (McGillivray 1993), in which a single basal stem arises from an underground tap root system. However, single-stemmed shrubs do not necessarily indicate this type of underground morphology. *P. acicularis*, *P. striata* and at least some forms of *P. quinquenervis* produce long stolon-like rhizomes that lie about 5 cm below the soil surface and from which one or several above-ground stems arise at irregular intervals. A clump of stems also may be produced from a single vertical, thickened taproot (e.g. *P. trinervis*) or from a branching, creeping, grossly thickened rhizome (*P. comata*, *P. saccata*).

Most Western Australian *Persoonia* species have lignotubers from which they regenerate after fire or other disturbances. In addition, some species apparently produce epicormic shoots after fire. Where information exists concerning the regenerative capabilities of species and the structures involved, it is included in the description of plant habit.

Plant stature, that is the orientation of the main branches, is included in the species descriptions. The terms used are defined by Stearn (1973).

The bark of most species of Persooniinae is hard and compact. It may be somewhat fissured or slightly flaky at the base of the main stem and is usually pale to mid-grey or brown in colour and somewhat mottled. Four species, however, possess a bark type markedly different from this. *P. falcata*, *P. levis*, *P. linearis* and *P. longifolia* all have lamellose-flaky bark consisting of many paper-thin layers which are dark brown or grey to black towards the outside layers but which are deep reddish-purple towards the inside. These layers are usually fissured and the bark as a whole thus becomes very flaky. This bark type seems similar to the underground bark that covers the lignotubers of many species and could conceivably be the result of homoeotic transformation (see e.g. Sattler 1988).

Indumentum

The simple, uniseriate, 3-celled hairs characteristic of the Proteaceae are found in all species of Persooniinae. One species, *P. spathulata*, also produces glandular hairs. The detailed histology of these is unknown but may resemble that of the uniseriate, multicellular, glandular hairs that are found in some species of *Grevillea* (Johnson & Briggs 1975, McGillivray 1993). Indumentum varies within and between different species and between different organs with respect to hair density, length, angle, curliness and colour. I have not used classical terms such as pubescent, villous, sericeous etc., to describe this variation because they often confound aspects of several independently varying attributes. For example, 'sericeous' implies something of the shininess of the hairs, while 'pubescent' does not. I have attempted to describe indumentum unambiguously by using separate descriptive terms for each attribute. Although these are actually continuously varying attributes, I have arbitrarily defined readily recognisable discrete states, as follows. Where hairs are present, their density is classified as sparsely hairy (with a few scattered hairs), moderately hairy (more than just a few scattered hairs but not obscuring the surface of the organ from view), or densely hairy (hairs obscuring the surface of the organ from view). Hair length is classified as short (most hairs less than 0.2 mm long), medium length (most hairs more than 0.2 mm long but less than 2 mm long), or long (most hairs more than 2 mm long). Hair angle is classified as patent (most hairs forming an angle of more than 45° to the surface of the organ), antrorsely spreading (most hairs forming an angle of less than 45° and more than 5° to the surface of the organ and pointing towards its apex), appressed (most hairs lying flat, i.e., forming

an angle of less than 5° to the surface of the organ and pointing towards its apex), or curly (most hairs without any specifiable angle).

Apart from the hairs on the gynoecium, the length, angle and colour of hairs does not vary sufficiently between different organs to warrant separate indumentum descriptions for each organ. Consequently, these attributes are included in a general description of hairs for each species. Only the density of hairs is described separately for each organ (apart from the gynoecium). Seven species possess hairy gynoecia and some of these may be recognised on the basis of gynoecium hairs alone. *P. trinervis*, *P. angustiflora* and *P. papillosa* have characteristically bicoloured ovary indumentum: most of the ovary is densely covered with greyish hairs but those at the tip are ferruginous.

Branchlets

Branchlets are defined here as stems that have not yet lost their leaves. They vary within and between species in indumentum and transverse-sectional shape. Combined with other characters, these may be useful in recognising some species.

The very youngest shoot tips are often densely hairy but on the older parts that have stopped lengthening, the hairs have usually thinned out to some extent. The beginning and end of a season's growth are usually more densely hairy than the middle. Branchlet hairs are gradually lost with age (i.e., the terminal cells fall off) and those that remain become bleached and dirty. Usually the hairs are lost completely before the leaves are abscised either because they have fallen off individually or because the whole epidermis is sloughed. Consequently, indumentum characters are described for fully elongated but young (less than one year old) stems.

The shape in transverse section of immature, elongating stems is often angular or flattened because of decurrent leaf bases. Most angular stems become terete when fully elongated although in some cases (e.g., *P. graminea*) the angles persist up to a year or more.

Leaves

The leaves of all species of Persooniinae are simple and entire and they mostly lack a well-defined petiole. The range of ontogenetic variation found in many other groups in the Proteaceae (see, e.g., Johnson & Briggs 1975) is unknown in the Persooniinae although in some species the leaves of seedlings and juveniles are known to differ somewhat in shape (e.g. *P. graminea*) or in size (e.g. *P. lanceolata*) from those of the adult. Variation in leaf size, morphology and anatomy within and between species is, however, considerable. Moreover, the leaf characters of many species are diagnostic and extremely useful in species recognition and are therefore described in detail.

The leaves of most species in the Proteaceae are alternate but in a few species (e.g. *Persoonia cordifolia*) there is a strong tendency to opposite-decussate or even ternate phyllotaxis. Other species occasionally produce branchlets with a few pairs of opposite or almost opposite leaves but such instances appear to represent a more or less random element of variation.

The extent of crowding of the leaves varies considerably between species. In some species nearly all of the internodes are less than 1–2 mm long and the leaves are described as 'crowded'. In other species however, the internodes are mostly longer than 2 mm and are described as 'not crowded' although several leaves may be crowded at the end of a seasonal growth unit and the last pair of leaves may be

opposite. This arrangement sometimes gives the superficial appearance of a terminal whorl of leaves. In a few species (e.g., *P. acicularis*, *P. pungens*) the leaves on the main branches are not crowded while those on short lateral branchlets are. *P. graminea* has a unique growth habit in that the leaves are mostly clustered at the ends of the vegetative shoots, often on the ends of long (up to 10 cm long) basal internodes. Usually, there are two to three leaves in each cluster, two of which are opposite. *P. micrantha* has a growth habit which is similar to this in that the leaves tend to be clustered at the distal tips of vegetative shoots along which several scale leaves are interspersed.

The angle between the leaf and the stem is diagnostic for some species but is often confounded in other species by leaf curvature. The leaf bases are shortly stem-clasping but the laminae often curve downwards just above the base to form a larger angle with the stem. The angle between the stem and the lamina is used to describe the leaf as erect (< 15°), suberect (15–45°), or patent (> 45°).

The leaf may be curved in a dorsiventral plane (that is, upwards or downwards in a horizontally held leaf) or in a lateral plane (that is, sideways in a horizontally held leaf). The dorsiventral curvature is described as curving upwards slightly or prominently, or downwards slightly or prominently, or not curving upwards or downwards. The degree of lateral curvature may be described in terms of bilateral symmetry. A leaf may be bilaterally symmetrical, slightly asymmetrical or prominently asymmetrical. The distinction between slightly and strongly asymmetrical leaves may be made by drawing the midvein as part of the circumference of a circle, delimiting a wedge of the circle. If the angle subtended by the wedge is less than 30°, then the leaf is described as slightly asymmetrical, if greater than 30°, then the leaf is prominently asymmetrical.

The leaves of many species are twisted to some extent. In some species they are twisted through about 90° at the base so that their lateral axis is held vertically (e.g. *P. falcata*). This attribute is not always readily observed on dried herbarium specimens but it may be useful for field identification. The leaves of some other species are twisted through more than 90°, up to 6 complete turns (e.g. *P. helix*). Any consistent degree of twisting through more than half a turn (180°) is easily observed even on herbarium specimens. Still other species exhibit no twisting at all.

Leaf shape and tip are described using the terminology of Stearn (1973). The leaf tip is described as pungent if it is sharp enough to pierce the skin.

Leaf length and width are extremely useful in species delimitation. Leaf length is measured from the bottom of the leaf base around the curve of the midvein. Leaf width is measured at the widest point.

Leaf texture varies considerably from species to species depending on the proportion of the leaf occupied by fibre bundles, the thickness of the cuticle, and the width and thickness of the leaf. Mesomorphic leaves are described as soft and flexible, while scleromorphic leaves are described as either leathery and flexible if they can be bent readily or hard and rigid if they cannot. This descriptive terminology simply reflects a subjective impression created by a number of continually varying attributes. Leaf texture was assessed on herbarium specimens, which are generally less flexible than live leaves.

The shape of a transverse section of the leaf varies considerably between and within species. In many species this shape is due to the distribution and relative sizes of veins and so it cannot be described independently of venation. There appear to be no precise single words which may be used to describe many of the transverse-sectional leaf shapes exhibited by *Persoonia*.

My solution to this problem is to describe imprecisely the general outline of the transverse section and then to detail the shape further by referring to the various ridges, grooves and raised veins which characterise it. For example, the word 'terete' strictly refers to a leaf in which the transverse section is a perfect circle (Stearn 1973) and indeed one species, *P. teretifolia*, has truly terete leaves with a single, central vascular bundle. Other species have leaves that are circular in the general outline of the transverse section but which have one or more longitudinal grooves or ridges. For example, *P. inconspicua* (Fig. 1a) has linear, revolute leaves that are virtually circular in transverse section, the opposite margins almost touching one another. This condition is described as 'subterete with a narrow longitudinal groove on the undersurface'. Other species such as *P. chapmaniana* (Fig. 2c) have leaves that are more or less radially symmetrical in outline but have a number of longitudinal ridges indicating the positions of enlarged, fibre-capped veins which may reach the epidermis. Such a cross-sectional shape may be described loosely as 'subterete'. The following qualifying phrase 'with 5 longitudinal ridges' adds further detail. In some cases the prominent longitudinal ridges may be so close to one another that they are contiguous (e.g., *P. bowgada*, Fig. 2e) or they may be separated by wide grooves (e.g., *P. hexagona*, Fig. 2d). In the former case the leaf is described as 'subterete with six narrow longitudinal grooves' while in the latter it is 'subterete with six longitudinal ridges'. Examples of the cross-sectional shape of leaves of various species are illustrated in figures 1–3.

Venation patterns exhibited in the Persooniinae vary from brochidodromous to acrodromous, parallelodromous and hyphodromous (sensu Hickey 1973). Veins of herbarium specimens are described as (i) obscure, that is, not evident on external examination or (ii) evident, raising the epidermis slightly or in some other way evident on external examination or (iii) prominent, raising the epidermis abruptly. Vein nomenclature is that of Hickey (1973) with some modifications: (i) only the midvein is regarded as primary, regardless of the prominence of other veins (ii) intramarginal veins are defined as the outermost pair of prominent secondary veins.

The leaves of most Western Australian *Persoonia* species are more or less concolorous. Some species, however, have bicolorous leaves due to a variety of factors. For example, the stomata of some species turn black on drying and when these are unevenly distributed on the leaf (e.g., only between sclerenchyma ribs) they may give the dried leaf a striated appearance. In other species the leaf structure is dorsiventrally differentiated so that the density of stomata is greater on the abaxial surface than on the adaxial and the mesophyll is differentiated into pallisade cells on the adaxial side and spongy cells on the abaxial. In such cases the leaf is paler on the undersurface.

In many species, the surface of mature leaves is rough to the touch. This may be caused by persistent protruding hair stalk cells, the terminal cells of which were present on the young leaf but have fallen off, or papillose epidermal cells. For all these conditions, the leaf surface is described as papillose (opposed to smooth). If it has the texture of sandpaper it is also described as scabrous and as scaberulous if it is rough to the touch but not as rough as sandpaper.

The immature leaves of most species are hairy to a greater or lesser extent and the terminology used to describe this variation is discussed above. The density of hairs varies greatly with leaf age: the leaf primordia of nearly all species are densely hairy but as they enlarge, differences in hair density appear within and between species. I have described the indumentum of young leaves between the following stages: (a) after they have enlarged somewhat from the primordial stage (b) full size but not yet mature. In nearly all species the leaves lose all of their hairs at or before maturity.

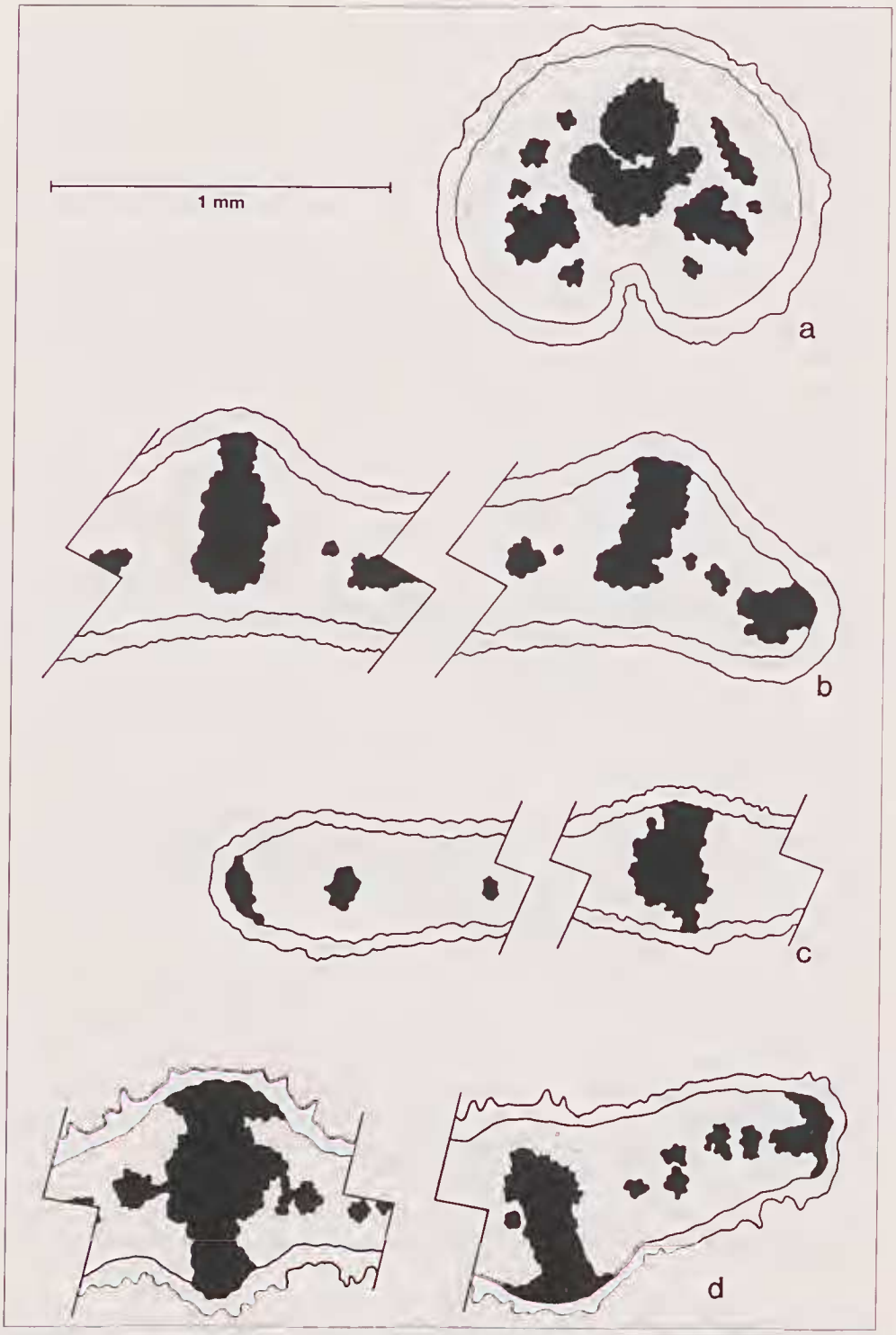

Figure 1. T.S. leaf at halfway point. **a**, *Persoonia inconspicua* (*P.H. Weston 140*); **b**, *P. rufiflora* midvein and margin (*P.H. Weston 309*); **c**, *P. micranthera* midvein and margin (*P.H. Weston 230*); **d**, *P. trinervis* midvein and margin (*P.H. Weston 149*). Black shading - vascular strands (fibres, xylem, phloem); outside, unshaded - epidermis; inside epidermis, unshaded - ground tissue.

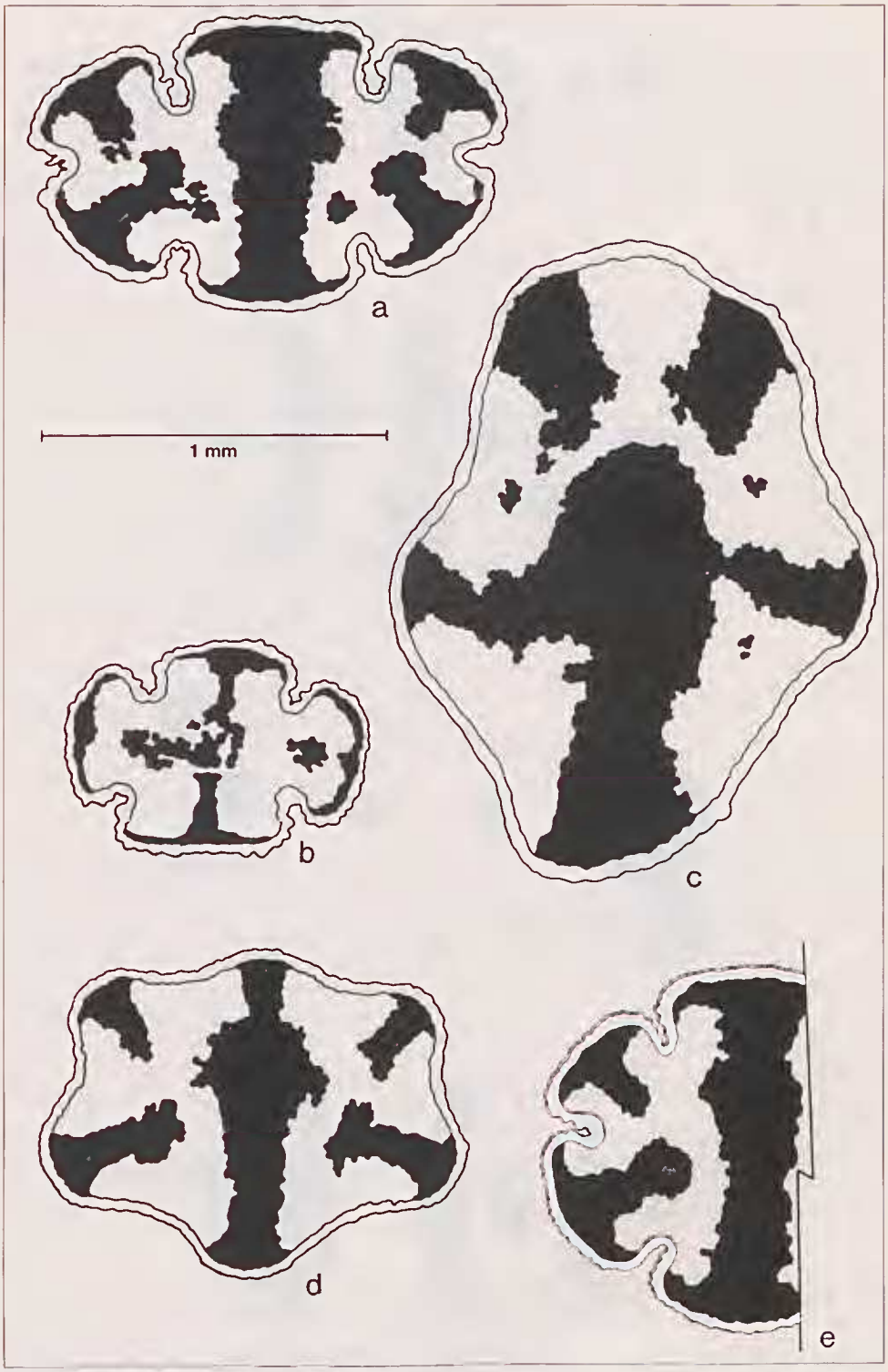

Figure 2. T.S. leaf at halfway point. **a**, *Persoonia angustiflora* (*P.H. Weston 307*); **b**, *P. acicularis* (*P.H. Weston 294*); **c**, *P. chapmaniana* (*P.H. Weston 159*); **d**, *P. hexagona* (*P.H. Weston 181*); **e**, *P. bowgada* (*P.H. Weston 290*). Shading as in fig. 1.

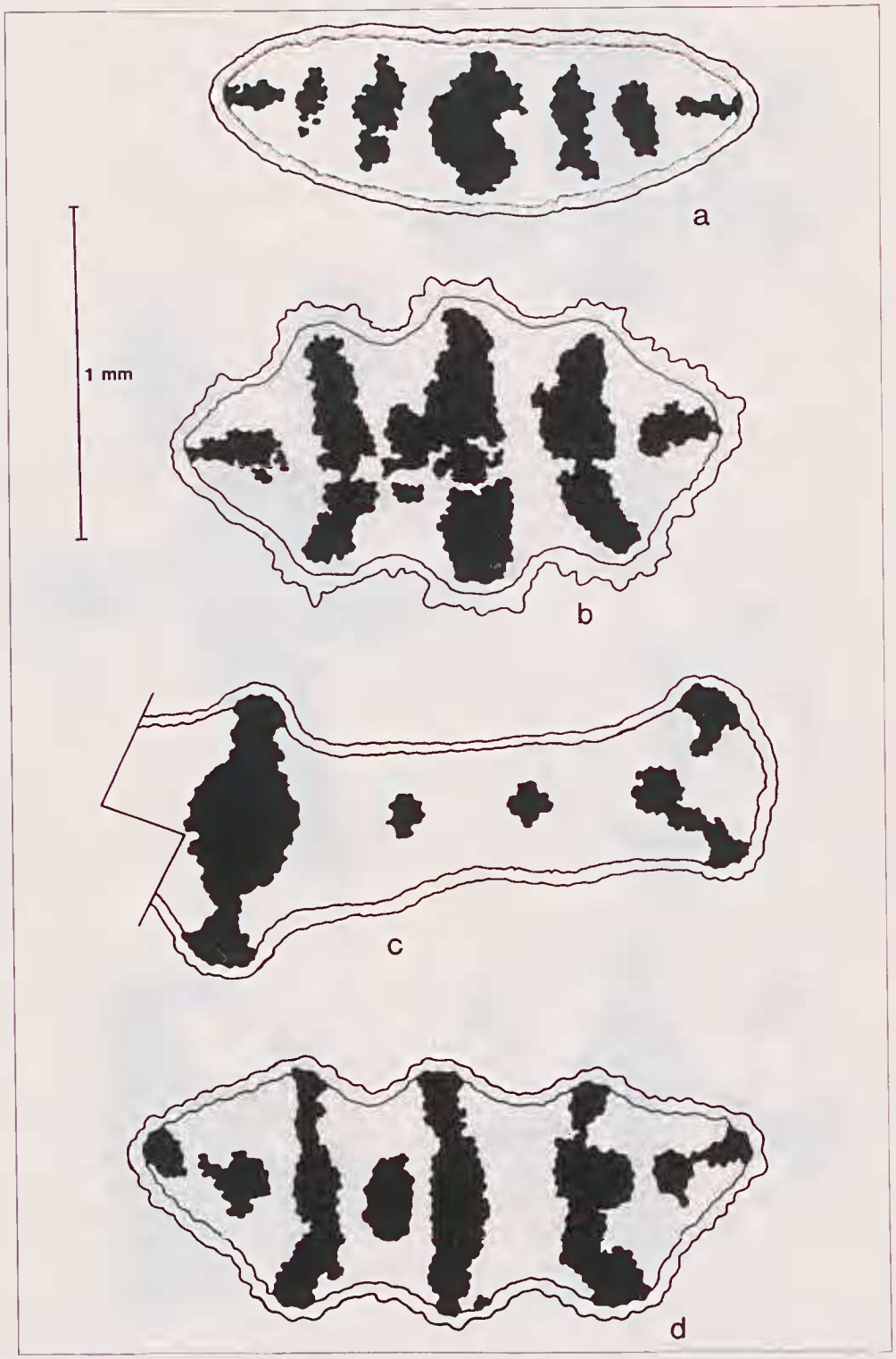

Figure 3. T.S. leaf at halfway point. **a**, *Persoonia quinquenervis* (*P.H. Weston 325*); **b**, *P. quinquenervis* (*P.H. Weston 141*); **c**, *P. graminea* (*P.H. Weston 211*); **d**, *P. striata* (*P.H. Weston 238*). Shading as in fig. 1.

Scale leaves

Scale leaves enclose dormant buds, usually becoming the basal-most phyllomes of shoots that grow from those buds. In inflorescence shoots the basal scale leaves usually subtend flowers, indeed in some species scale leaves are the only flower-subtending phyllomes. The shape of scale leaves is described using the plane shape terminology of Stearn (1973). The indumentum of scale-leaves is not described since it often wears off quickly and does not usually differ greatly from that of the branchlets.

Inflorescences

It is often difficult to formulate homology hypotheses for inflorescences: although homologies are readily recognisable for constituent parts (i.e., flowers, leaves, scale leaves, stems and buds), it is the relative arrangement and behaviour of these different parts that characterise different inflorescence types. The fundamental problem in inflorescence analysis is the recognition of homologous units for comparison, that is, of repeated structural units or modules of growth. Judging where a flower begins and ends usually presents no problem since flowers usually are well defined units; by contrast, judging where an inflorescence begins and ends is often a contentious issue. Further complicating this problem of demarcation is the much greater phenotypic variability within inflorescences than is found in clearly delimited organs. Since variation in inflorescence structure reflects the differential production of various organs during growth, it seems reasonable to look to shoot ontogeny as a suitable basis on which unit inflorescences may be defined.

Johnson & Briggs (1975) treated the seasonal growth unit (SGU) as a fundamental unit of inflorescence structure in the Proteaceae. In their later paper on inflorescences in the Myrtaceae, they defined the SGU as:

> a shoot, or branched system of shoots, formed within a single growing season and arising (terminally or laterally) from an axis formed in a previous growing season. (Briggs & Johnson 1979: 175).

Although their approach is likely to be inapplicable in groups with non-seasonal growth patterns, in which cases Grimes's (1992) more general concept of repeating growth unit (RGU) may be appropriate, it is particularly applicable to groups like the Persooniinae in which growth is markedly seasonal. In such groups the SGU is delimited by naturally defined characteristics of shoot ontogeny. In the Persooniinae (and in most other Proteaceae) boundaries between successive seasonal growth units are easily recognised, even on herbarium specimens, by denser stem indumentum and crowded scale-leaves or scale-leaf scars. For these reasons I have adopted Briggs & Johnson's (1979) method and terminology in determining and describing inflorescence characters.

Inflorescences in the Persooniinae (flower-bearing SGUs or unit inflorescences *sensu* Johnson & Briggs 1975) are racemose (botryine). Occasionally they may branch but this behaviour is erratic and appears to be a phenotypic response to favourable growing conditions. Inflorescences vary with respect to several features (discussed below):

(a) The terminal bud may or may not continue to grow beyond the flowering region of the shoot, i.e., the SGU may be auxotelic or anauxotelic.

(b) The floral bracts (floral pherophylls *sensu* Briggs & Johnson 1979) may be leaves, reduced leaves or scale leaves.

(c) They may be basitonic (flowers are subtended by phyllomes at the base of the SGU), mesotonic (flowers are subtended by phyllomes in the middle of the SGU),

acrotonic (flowers are subtended by phyllomes at the tip of the SGU), or pantotonic (flowers are subtended by phyllomes throughout the SGU).

(d) They may be terminal (i.e., developing from a resting apical bud), or subterminal to axillary (i.e., developing from a resting lateral bud).

(e) The relative size of constituent parts.

Inflorescences in the Proteaceae are exclusively blastotelic, but auxotelic inflorescences are unique to the Persooniinae, as are foliose floral bracts. In typical auxotelic inflorescences of the Persooniinae, the terminal bud keeps growing beyond the flowering region as a leafy shoot, terminating in a dormant apical bud that grows on into another inflorescence in the following growth season.

Almost all species that produce terminal inflorescences also produce lateral ones, although in some species these are represented by only occasional subterminal inflorescences. Some species (e.g. *Acidonia microcarpa*, *Persoonia rufiflora*) produce only lateral inflorescences.

The inflorescences of most Persooniinae are basitonic or pantotonic, that is, the flowering region is more or less basal in the SGU. Mesotonic and acrotonic inflorescences, that is ones in which the flowering region is separated from the base by a non-flowering leafy axis, are found in only four species in the Persooniinae. Two fundamentally different types of mesotony/acrotony are found in the Persooniinae:

(a) *P. conata* and *P. saccata* regenerate after fire from lignotubers. Usually the shoots start to grow immediately after a fire (mostly in the summer) and continue to grow through the following winter, flowering the following summer, finally terminating in a dormant apical bud. Each such shoot is therefore an SGU, but is not comparable ontogenetically to those of other species. Basitonic or pantotonic inflorescences are produced in succeeding growth seasons. Many other species also regenerate from lignotubers but none produce inflorescences as the first regenerating SGUs.

(b) The eastern species *P. pinifolia* and *P. isophylla* produce acrotonic or mesotonic inflorescences along with pantotonic or basitonic inflorescences throughout the reproductive life of the plant; they are not lignotuberous.

All of the characters discussed above, as well as the number of flowers and the rachis length are included in the species descriptions.

Pedicels

Pedicel length varies between individual flowers or fruits of a plant, during flower or fruit development and within and between species. The range of variation of pedicel length at a comparable ontogenetic stage is useful in diagnosing some species and so is included in the species descriptions. In some eastern Australian species, the pedicels lengthen considerably during fruit development but this does not seem to be very pronounced in any Western Australian species. Consequently, pedicel length between anthesis and fruit maturation is more or less comparable and it is this range of ontogenetic stages in which pedicels were measured.

Some species produce long pedicels at the base of the inflorescences, grading into much shorter pedicels at the tips. To some extent this reflects ontogenetic variation along the acropetally developing inflorescences but an examination of post-flowering inflorescences showed this to be present after completion of development and therefore partially independent of ontogenetic variation.

Flowers

Flower morphology varies considerably within the Persooniinae, providing many characters for species discrimination.

The whole flower and the relationships of its parts

One species-group in *Persoonia* (section *Pycnostylis* Meisn. = *Pycnonia* L.A.S. Johnson & B.G. Briggs) has irregular flowers that are quite unlike those of any other group in the Proteaceae. The gynoecium is about half the length of the stamens and is hooked towards the anterior (i.e. ventrally) so that the distal tip sits (or is 'buried' to use Bentham's expression) in a pouch of the anterior (ventral) tepal below (i.e. proximal to) the anthers (Fig. 4F). The whole flower is slightly curved so that the lateral tepals are also asymmetrical (Fig. 5). The rest of the Persooniinae have superficially regular flowers with each tepal, anther and hypogynous gland of similar morphology and position relative to the others (Fig. 4A–E). None of these species has strictly actinomorphic flowers, however, because the gynoecium is never radially symmetrical. The gynoecium is held in the centre of the flower for its entire length and in all but one species (discussed below) is longer than, or slightly shorter than, the stamens and is exserted. More or less regular flowers are found in every subfamily of the Proteaceae and are thus postulated to be plesiomorphous for the Persooniinae. In *Toronia toru*, the gynoecium is slightly shorter than the staminal filaments and in this respect resembles the gynoecium of the irregular-flowered species. However, unlike the latter, in *T. toru* the tip of the style is incurved towards the posterior (dorsal) side of the flower. Moreover, its tepals are strongly recurved so that the gynoecium is not concealed and its tip is nowhere near any of the tepals.

Some species of the Persooniinae have 'open' flowers in which the anthers usually curve outwards and are not held close to the gynoecium or to one another after anthesis (Fig. 4A,B). Most species, however, have more 'closed' flowers in that the anthers are held close together and to the gynoecium, forming a more or less tightly-held bundle of reproductive organs for at least part of their length. This apparently blocks easy pollinator access to the nectaries at the base inside the flower, forcing the pollinating vectors (bees of various families — Armstrong 1979, P. Bernhardt pers. comm.) to 'burrow' between the anther loculi and the gynoecium in order to reach the nectaries. In some species, the anthers are held together only at their bases, the tips curving outwards (Fig. 4D). In others the anthers are straight and are held close together and to the gynoecium right to the tips of the loculi; only the appendages recurve outwards (Fig. 4E), or even they may be straight (Fig. 4C). Irregular flowers (Fig. 4F) show another type of anther arrangement. Although the anthers are held close together to the tips of the loculi or anther appendages, they are not held close to the gynoecium since it does not extend even to the bases of the anthers. The anthers are not held in a radially symmetrical arrangement (e.g. Fig. 8A–C) but in a '3 + 1' arrangement in which the lateral anthers and the ventral anther form a radially symmetrical bunch of 3, outside which is the dorsal anther (Fig. 8D).

Flower aspect (i.e. the way the pedicels hold the flowers) varies between species. In most regular-flowered species the pedicels form an acute angle to the main axis and are more or less straight, though in some there is a slight tendency for the pedicels to curve upwards. Consequently, in some species the flowers are held more or less suberect while in others they may be erect, horizontal or pendulous depending on the orientation of the inflorescence axis and the positions of their subtending bracts. In other species the pedicels are curved downwards so that the flowers are consistently pendulous or mostly so (e.g., *Persoonia graminea*). Quite distinct are the

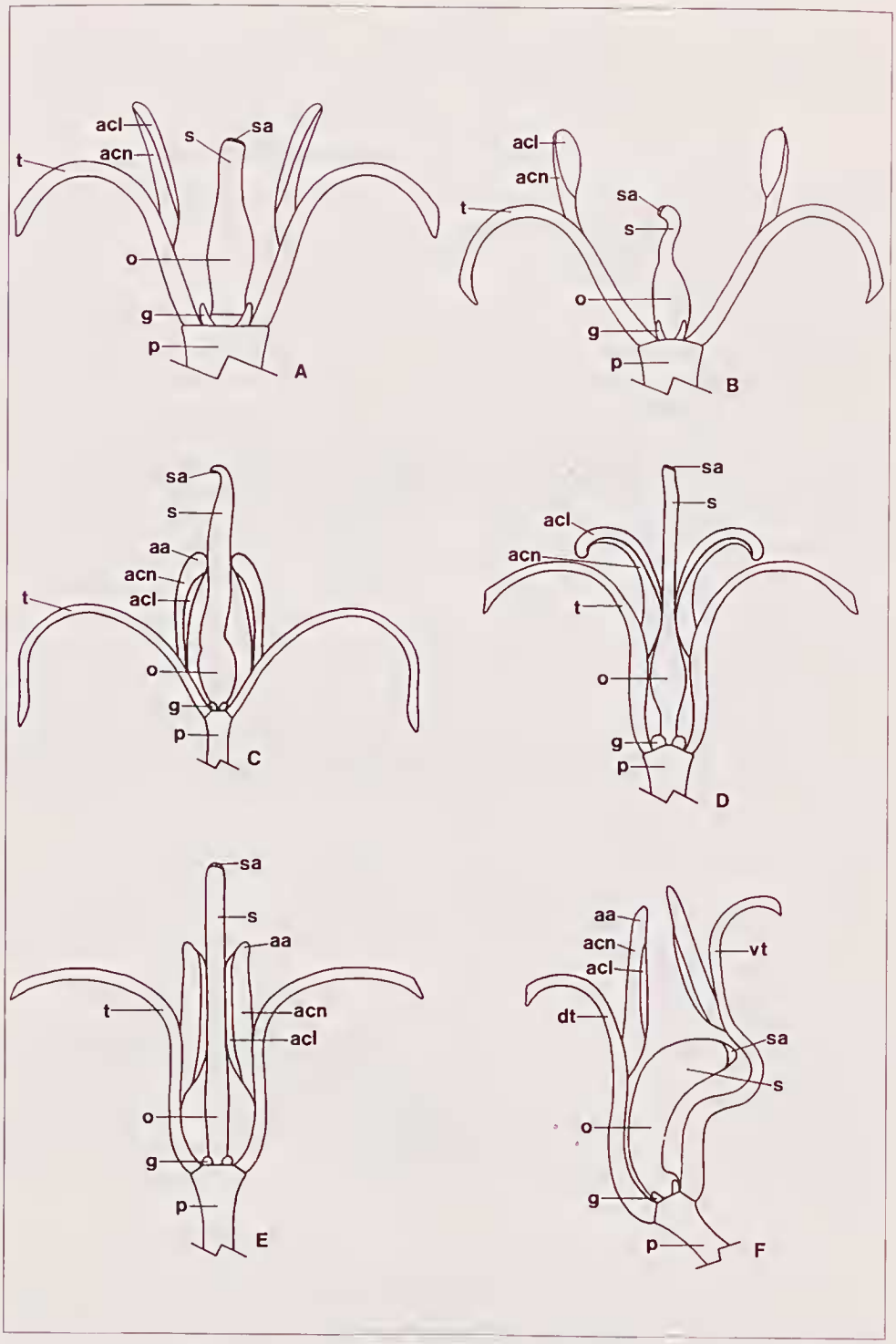

Figure 4. Diagrammatic representation of median longitudinal sections through flowers of selected species. **A**, *Garnieria spathulifolia*; **B**, *Toronia toru*; **C**, *Acidonia microcarpa*; **D**, *Persoonia coriacea*; **E**, *P. quinquenervis*; **F**, *P. saccata*. acl - anther loculus; acn - anther connective; g - hypogynous gland; o - ovary; p - pedicel; s - style; sa - stigma; t - tepal.

irregular-flowered species: the pedicels are straight and form an acute angle with the main axis but the receptacle is oblique so that the flowers are held consistently in a more or less horizontal position with the ventral tepal underneath.

Some species of *Persoonia* are strongly scented and the nature of the scent emitted varies between species. Unfortunately, reliable comparative information on floral scents in *Persoonia* is not available.

Tepals

Tepal colour in most species of the Persooniinae is some shade of yellow while a few species have white (e.g. *Garnieria spathulifolia*), green (e.g. some individuals of *Persoonia graminea*) or red-marked tepals (e.g. some individuals of *P. conata*).

Unicellular papillae are often present on the inside of the tepals. They are blunt, greyish in colour and are often minute. However, in some species they are up to 1 mm long and resemble hairs, in which case they are described as 'hair-like papillae'. Usually they are grouped in two marginal rows or patches near the base of each tepal.

In species with irregular flowers, the shapes of dorsal, lateral and ventral tepals are quite different. The dorsal tepal is bilaterally symmetrical and is the only one that can be compared meaningfully with respect to shape and size to the tepals of species with regular flowers. Its length and width are therefore included in the species descriptions along with the tepal length and width of regular-flowered species. The tepal shapes of most species (lateral and ventral tepals of irregular flowers in particular) are not easily described using classical botanical terms so I have provided only brief descriptions of tepal shape. These may be checked against the representative sample of tepals illustrated in Figures 5 and 6.

The tepals of some species in the Persooniinae are involute in bud to some extent and, when the flowers open, the lateral infolded 'flaps' spread out flat (cf. Orchard 1983). These flaps are thinner than the main body of the tepal and are never vascularised. In some species they may be large enough to be prominent so I have included the width of the tepal flaps in the species descriptions. This character is variable within many species and in some cases it is difficult to judge whether flaps are absent or present.

Stamens

There is not always an obvious morphological or anatomical differentiation of the stamen into anther and filament apart from the clearly distinct anther loculi. Consequently, I have defined the filament as that part of the stamen below the base of the anther loculi, the anther as the part above the base of the anther loculi, the connective as that part of the anther not included in the loculi and the anther appendage as that part of the connective that extends past the tips of the anther loculi.

The stamens of all species of Persooniinae are adnate to the tepals for at least part of their length. In most species the filaments are entirely adnate to the tepals but in some they are free at their tips to a greater or lesser extent. Similarly, in many species the anthers are entirely free while in others they are adnate to the tepals for part of their length. In *P. hakeiformis* the ventral stamen is entirely adnate to the ventral tepal. Stamen-tepal adnation is useful in distinguishing a number of species and is thus included in the species descriptions. It is described in two parts: (a) whether the filament is free at its tip and (b) the fraction of the anther loculus length which is adnate. The filament length and filament length/tepal length ratio vary considerably within *Persoonia* and are included in the species descriptions.

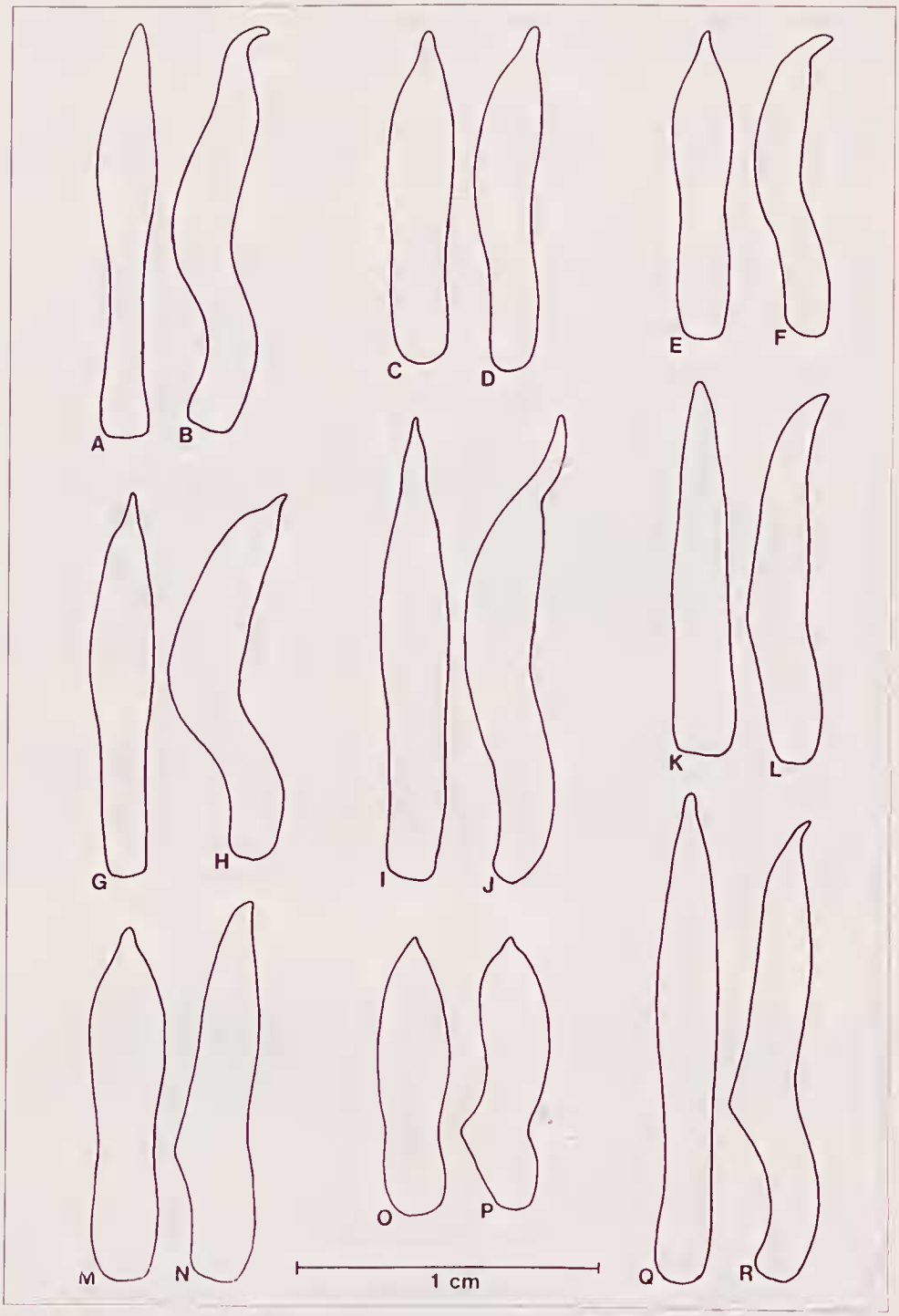

Figure 5. Outlines of the flattened dorsal and lateral tepals of some zygomorphic-flowered *Persoonia* species; in each pair the dorsal tepal is on the left. **A–B**, *P. falcata* (*N. Byrnes 1036*); **C–D**, *P. biglandulosa* (*P.H. Weston 291*); **E–F**, *P. brachystylis* (*P.H. Weston 296*); **G–H**, *P. saundersiana* (*A.M. Ashby 1683*); **I–J**, *P. stricta* (*P.H. Weston 306*); **K–L**, *P. teretifolia* (*P.H. Weston 242*); **M–N**, *P. saccata* (*P.H. Weston 327*); **O–P**, *P. hakeiformis* (*P.H. Weston 259*); **Q–R**, *P. comata* (*P.H. Weston 281*).

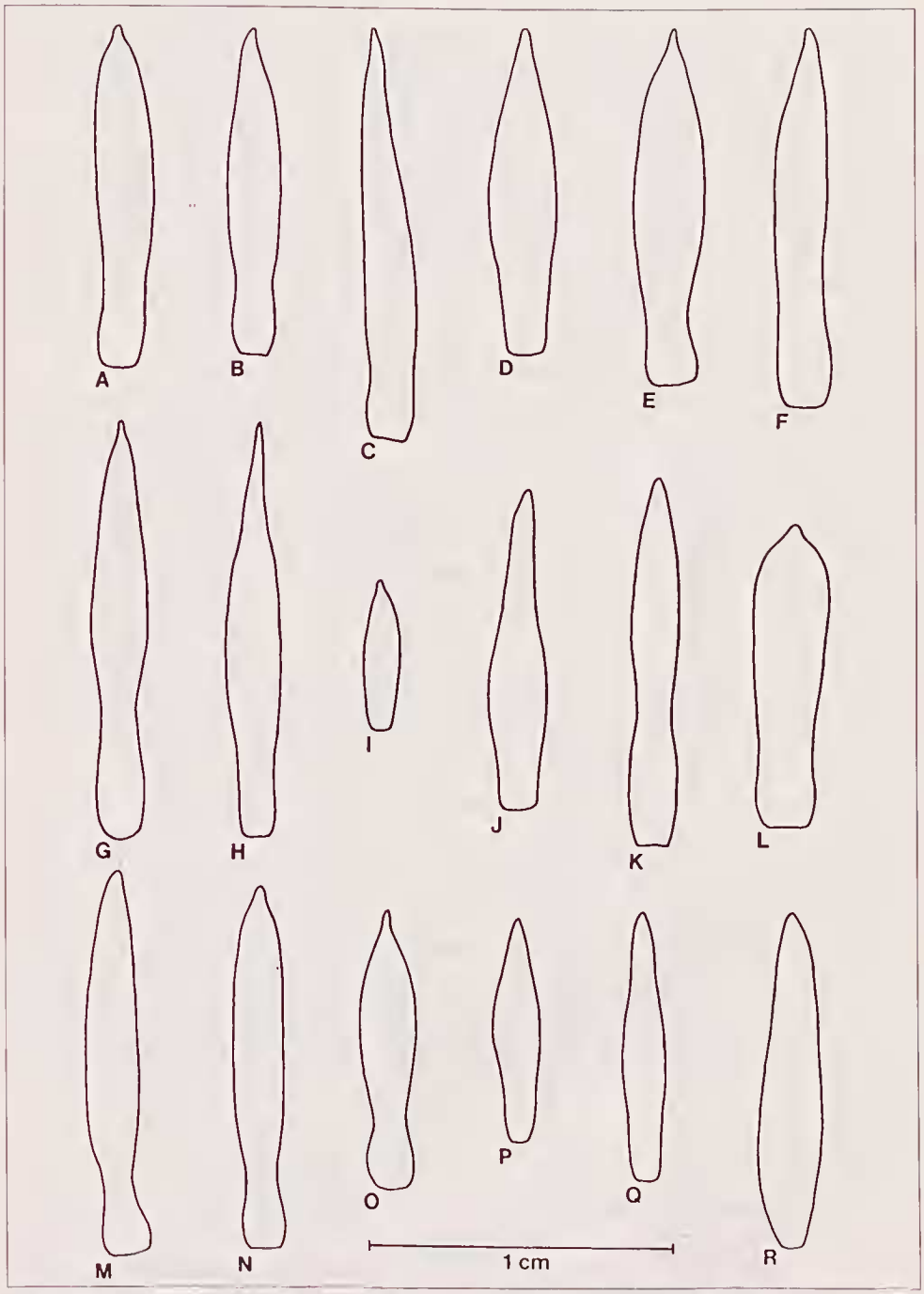

Figure 6. Outlines of the flattened tepals of *Acidonia microcarpa* and some regular-flowered *Persoonia* species. **A**, *P. trinervis* (*A.S. George 9228*); **B**, *P. angustiflora* (*P.H. Weston 180*); **C**, *P. hexagona* (*P.H. Weston 298*); **D**, *P. striata* (*P.H. Weston 238*); **E**, *P. quinquenervis* (*P.H. Weston 141*); **F**, *P. acicularis* (*P.H. Weston 301*); **G**, *P. rudis* (*C.A. Gardner 10270*); **H**, *P. filiformis* (*P.H. Weston 278*); **I**, *P. graminea* (*A.S. George 11772*); **J**, *P. chapmaniana* (*C. Chapman s.n., 29 Sep 1970*); **K**, *P. longifolia* (*B.T. Goadby B2369*); **L**, *P. elliptica* (*P.H. Weston 328*); **M**, *P. dillwynioides* (*P.H. Weston 241*); **N**, *P. pungens* (*P.H. Weston 162*); **O**, *P. coriacea* (*P.H. Weston 125*); **P**, *P. rufiflora* (*A.S. George 6746*); **Q**, *P. brevirhachis* (*E. Wittwer 166*); **R**, *A. microcarpa* (*P.H. Weston 223*).

Anthers may be white, pinkish mauve, pale to bright or greenish yellow or yellow with white tips, but only two Western Australian species vary significantly in anther colour: *Persoonia teretifolia* (pale yellow to bright yellow with white tips) and *P. graminea* (yellow to green with black tips). In all other species, one of two quite distinct character states is present: white or yellow to greenish yellow.

In many species of the Persooniinae, the anther connective is prolonged beyond the tips of the anther loculi to form an appendage. Meisner (1856) and Bentham (1870) both used the presence or absence of an anther appendage as an important key character but the distinction between these states is not as absolute as they stated it to be. One species, *P. longifolia*, is polymorphic for presence/absence of an appendage, and two others, *P. dillwynioides* and *P. pentasticha*, sometimes have such short appendages that they may be described as vestigial. All other species, however, can be classified unmistakably as possessing appendages or not.

The shape and size of anther appendages as well as the ratio of appendage length: loculus length are useful in species diagnosis so these characters are included in the species descriptions where applicable. The terms used for describing anthers may be compared with the sample of anthers illustrated in Figure 7. In cases where the appendage is less than 1/20 the length of the loculi it is recorded as absent. The shapes of appendages vary from more or less oblong, globular or triangular to filiform. In many species the appendage is recurved to some extent (e.g., Fig. 7J,L,P) while in others it follows the line of the connective (e.g., Fig. 7D,F,G,N,R). In the descriptions I have included this information in the overall description of anther morphology. Hence the anthers of *P. rudis* (Fig. 7K,L) are described as '± straight but abruptly reflexed through 180 degrees at the appendage' while the anthers of *P. quinquenervis* (Fig. 7I,J) are described as '± straight but reflexed at the appendage up to almost 90 degrees', those of *P. dillwynioides* (Fig. 7E,F) as 'curved outwards towards the tips' and the anthers of *P. comata* (Fig. 7Q,R) are '± straight'.

Most species in the Persooniinae have sublatrorse anthers (e.g., Fig. 8A,B; Fig. 9A). In this state, each anther loculus is oriented at an angle of about 90 degrees to the other loculus; the connective is much narrower than the two loculi together. In some species the anthers are more or less introrse (e.g., Fig. 8C,D, Fig. 9B,C). In this state the loculi are oriented in the same plane and the thick connective extends around to the sides of the loculi; the connective is usually as wide as, or wider than, the two loculi together. One species, *Acidonia microcarpa* (Fig. 9D), possesses anthers with an unusual structure. Although the connective is wider than the loculi, it is thin, gently incurved and almost leaf-like, unlike the connectives of other species with introrse anthers. Furthermore, although the loculi are not oriented at right angles to one another, they are not nearly as inward-pointing as those of other species with introrse anthers.

The most rigorous way of checking these character states is by examining transverse sections of flowers or flower buds but they can also be observed macroscopically, so I have included them in the species descriptions. The degree to which the connective extends laterally beyond the sides of the loculi in introrse anthers varies somewhat: in some species it is quite prominent (e.g., Fig. 9B,C) while in others the connective is about as wide as the loculi (e.g., Fig. 8D). or only slightly wider (e.g., Fig. 8C). The degree of lateral extension is included in the species descriptions.

Most species of Persooniinae have glabrous anther loculi but in two species, *P. comata* and *P. saccata*, they are ciliate with minute, one-celled papillae.

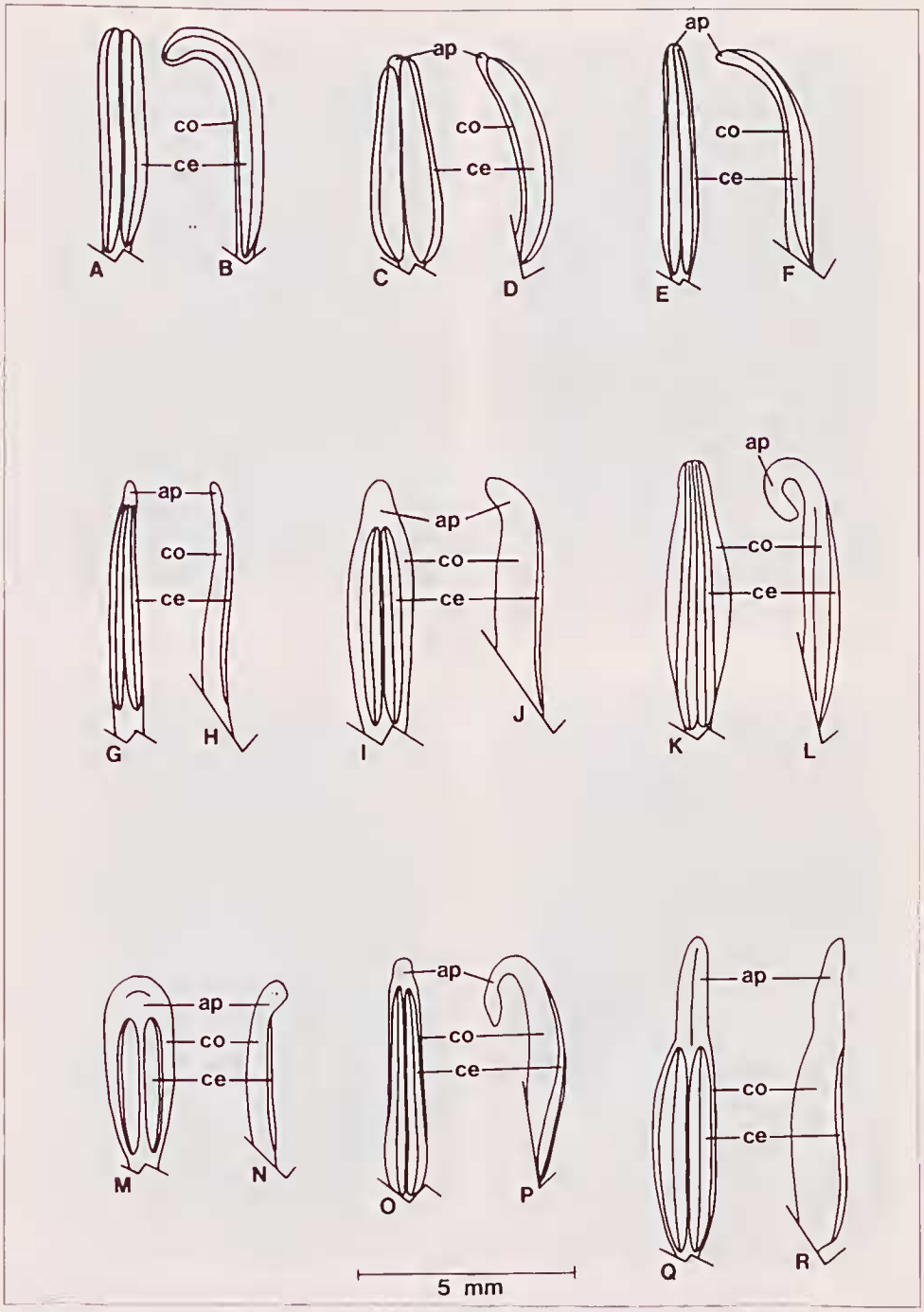

Figure 7. Adaxial and lateral views of the anthers of *Acidonia microcarpa* and some *Persoonia* species. In each pair, the adaxial view is on the left. **A–B**, *P. elliptica* (*P.H. Weston 328*); **C–D**, *P. chapmaniana* (*C. Chapman s.n., 11 Oct 1981*); **E–F**, *P. dillwynioides* (*P.H. Weston 241*); **G–H**, *P. acicularis* (*P.H. Weston 301*); **I–J**, *P. quinquenervis* (*P.H. Weston 141*); **K–L** *P. rudis* (*C.A. Gardner 10270*); **M–N**, *A. microcarpa* (*P.H. Weston 223*); **O–P**, *P. teretifolia*, dorsal anther (*P.H. Weston 242*); **Q–R**, *P. comata*, dorsal anther (*P.H. Weston 281*). ap - anther appendage, ce - anther loculus, co - anther connective.

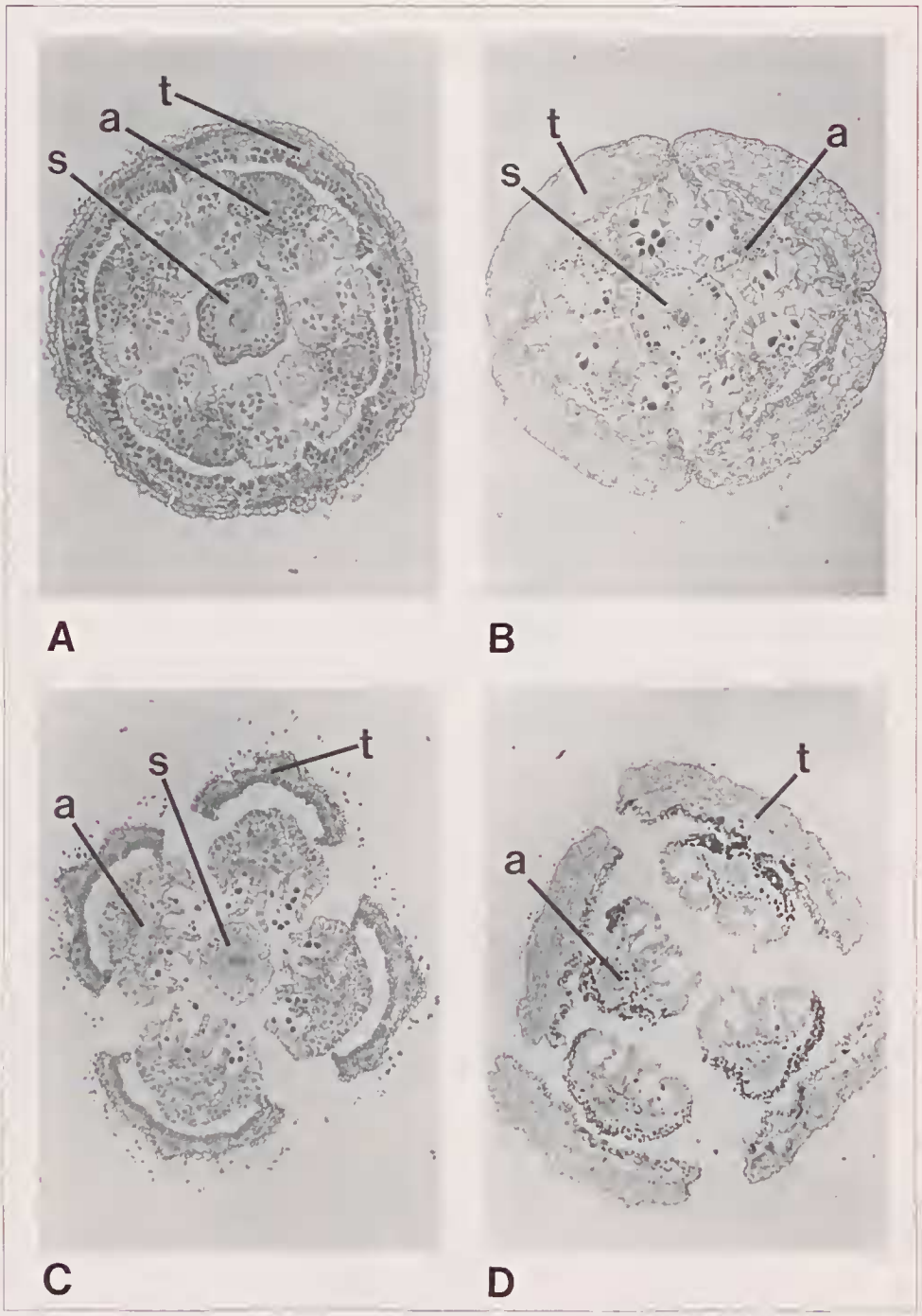

Figure 8. T.S. flower buds of some *Persoonia* species showing a range of anther position and morphology. The sections were taken about half-way along the anther loculi. A, *P. pinifolia* (*P.H. Weston 108*) – anthers symmetrically positioned, sublatrorse; B, *P. graminea* (*P.H. Weston 211*) – anthers symmetrically positioned, sublatrorse; C, *P. angustiflora* (*C. Chapman s.n., 11 Oct 1981*) – anthers symmetrically positioned, introrse; D, *P. biglandulosa* (*P.H. Weston 292*) – anthers in '3 + 1' arrangement, introrse. Scale: A x 29; B x 29; C x 21; D x 14. a - anther, s - style, t - tepal.

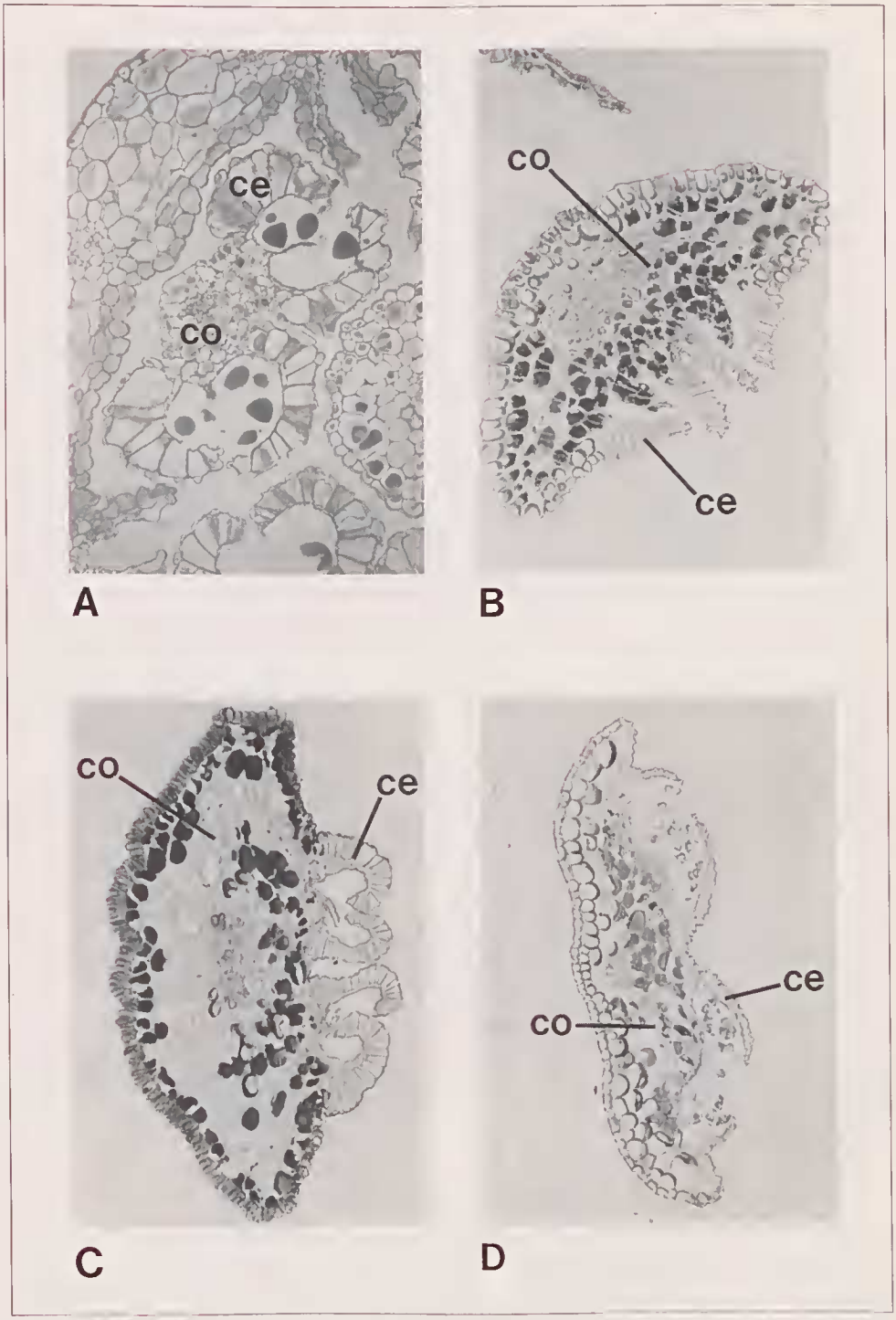

Figure 9. T.S. anthers of *Acidonia microcarpa* and some *Persoonia* species. The sections were taken about half-way along the anther loculi. **A**, *P. graminea* (*P.H. Weston 211*); **B**, *P. filiformis* (*P.H. Weston 277*); **C**, *P. hakeiformis* (*P.H. Weston 259*); **D**, *A. microcarpa* (*P.H. Weston 218*). Scale: **A** x 72; **B** x 53; **C** x 32; **D** x 44. ce - anther loculus, co - anther connective.

Gynoecium

The gynoecium was mentioned briefly above, with respect to floral symmetry, but a number of other characters of the gynoecium are also used in species discrimination.

The length of the gynoecium is useful in discriminating between some species. In flowers with hooked gynoecia this is measured around its curve.

The shape of the gynoecium is not described easily using ordinary botanical terms and I have not provided lengthy descriptions of gynoecium morphology. Instead, I have illustrated a representative sample of gynoecia (Fig. 10, 11) and my descriptive terminology may be compared with these illustrations.

In most species of Persooniinae the ovary is distinctly thicker than the base of the style and is demarcated clearly from it (Fig. 10a–e). In some of the regular-flowered *Persoonia* species, however, the ovary is no thicker (and is sometimes narrower) than the base of the style (Fig. 10f,g).

In some species the style is of an even thickness from the base to the tip but in most species there is some variation in thickness. For example, there is a whole range of variation from an untapered style (e.g., Fig. 10c) to one that is markedly tapered towards the tip (e.g., Fig. 10d) or gradually thickened towards the tip (e.g., Fig. 10b). In three species with irregular flowers, *P. hakeiformis*, *P. saccata* and *P. comata*, the tip of the style is usually swollen so that it is thicker than any other part of the gynoecium (Fig. 11a–c). The gynoecia of *P. saundersiana*, *P. stricta* and *P. kararae* (Fig. 11h–j) are prominently bent or 'elbowed' between the style and the ovary and near the tip of the style, whereas the gynoecia of the other species with irregular flowers are not.

Swollen style tips function as pollen presenters in many genera in the subfamilies Grevilleoideae and Proteoideae, but stylar pollen presentation is not known in the Persoonioideae.

Apart from the hooked gynoecia of species with irregular flowers there are many departures from the straight gynoecium condition in the Persooniinae. In some species the style is sinuate or bent to some extent (e.g. Fig. 10a,b,e), and these irregularities are described in the species descriptions where they are consistent.

In some species of *Persoonia*, the style has eight longitudinal ridges that may extend the full length of the style or be restricted to the basal part. In some species they are more pronounced than in others. In other species the styles are more or less terete when alive but become wrinkled on drying; the ridges thus produced, however, are not regularly arranged.

In all species of the Persooniinae, there is an abscission zone either at the base of the gynoecium or distinctly above the base on the stipe (e.g., Fig. 10c) and when the fruit is ripe it is abscised at this point. In dried flowers this abscission zone is well marked as a notch.

Hypogynous glands

The majority of species in the Persooniinae possess four hypogynous glands of about equal size and similar morphology (e.g. Fig. 10, Fig. 11a–e). In several irregular-flowered species (Fig. 11f–j), the dorsal pair of glands is either missing or minute. There is minor variation in gland morphology between species but not enough to warrant inclusion in the species descriptions.

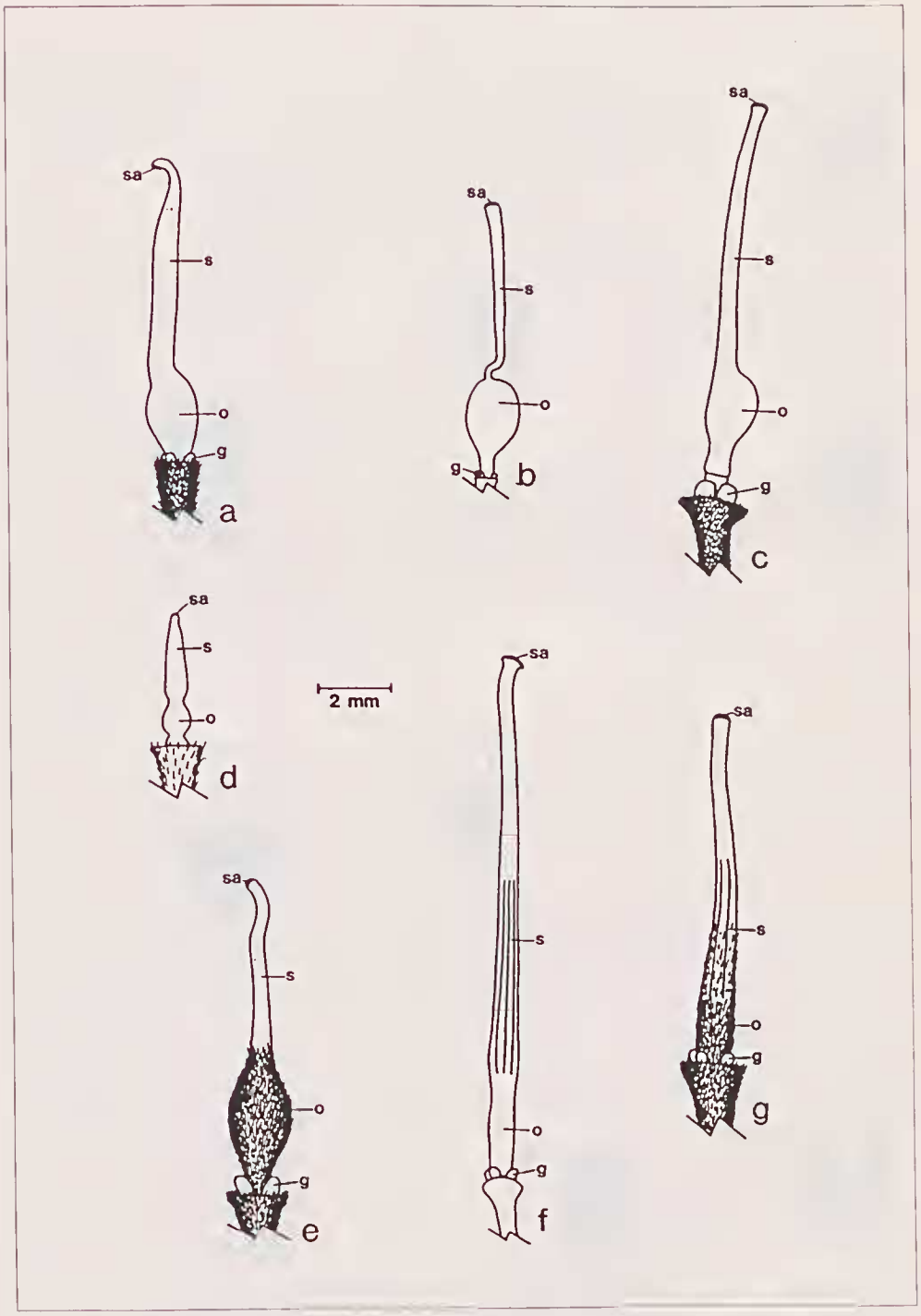

Figure 10. Lateral views of gynoecia of *Acidonia microcarpa* and some species of *Persoonia* with regular flowers. **a**, *A. microcarpa* (*P.H. Weston* 223); **b**, *P. rufiflora* (*C. Chapman s.n., 8 Sep 1981*); **c**, *P. longifolia* (*B.T. Goadby* 65); **d**, *P. graminea* (*P.H. Weston* 211); **e**, *P. chapmaniana* (*C. Chapman s.n. 11 Oct 1981*); **f**, *P. filiformis* (*C. Chapman s.n., 14 Nov 1981*); **g**, *P. bowgada* (*P.H. Weston* 287). g - hypogynous gland, o - ovary, s - style, sa - stigma.

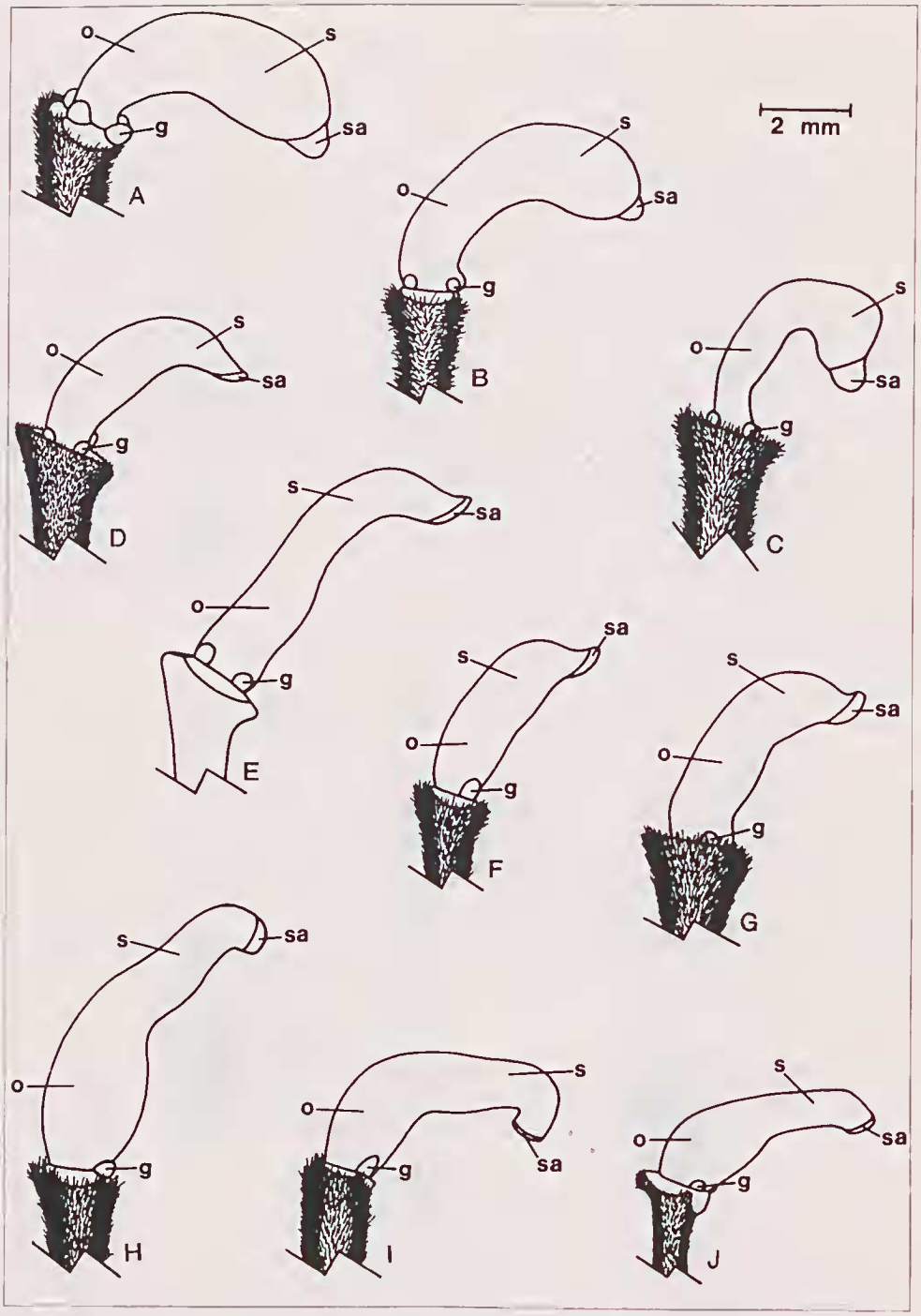

Figure 11. Lateral views of gynoecia of species of *Persoonia* with zygomorphic flowers. **A**, *P. saccata* (*C. Chapman s.n. Nov 1981*); **b**, *P. comata* (*P.H. Weston 265*); **C**, *P. hakeiformis* (*P.H. Weston 259*); **D**, *P. teretifolia* (*P.H. Weston 242*); **E**, *P. falcata* (*K.F. Kenneally 5547*); **F**, *P. biglandulosa* (*P.H. Weston 291*); **G**, *P. brachystylis* (*P.H. Weston 297*); **H**, *P. stricta* (*P.H. Weston 306*); **I**, *P. saundersiana* (*W.B. Alexander 1278*); **J**, *P. kararae* (*J.S. Beard 7198*). g - hypogynous gland, o - ovary, s - style, sa - stigma.

Fruits

The fruits of all Persooniinae are drupes (Johnson & Briggs 1975, Strohschen 1986). These vary in overall shape from globose to ellipsoid, ovoid or obovoid and often are compressed laterally to a greater or lesser extent. Variation is continuous and in some cases intraspecific variation in drupe shape is considerable. However, it is useful for distinguishing some species and is thus included in the descriptions.

The orientation of the long axis of the drupe relative to a line drawn between its point of attachment and the base of the style (i.e., relative to its 'true axis') varies considerably between species (Fig. 12). In the drupes of some species the long and true axes coincide (e.g., Fig. 12B) whereas in others these axes are at an angle to one another (e.g., Fig. 12A,C–I). This variation seems to reflect partially the orientation of unfertilised ovules in the ovary. Species that have a single, completely pendulous ovule often produce radially symmetrical drupes whereas those with one or two subpendulous ovules produce asymmetrical drupes. The terms that I have used to describe these states may be compared with the sample of drupes illustrated in Figure 12 and follow the solid-shape terminology of Stearn (1973). A continuum of variation is found linking the types shown in Figure 12A–C,E,H,I. However, two types of drupe are distinctly different from the others in this character. In *P. longifolia* (Fig. 12F) the whole drupe, including the embryo, becomes curved during development so that at maturity it may be somewhat reniform with the style and stipe relatively close to one another, and the embryo crescentic in shape. Quite different again are the drupes of *P. rufiflora*, *P. brevirhachis* and *P. inconspicua*, in which the axis of elongation of the pyrene is perpendicular, or almost so, to the axis between stipe and style (e.g., Fig. 12D,G).

The size of drupes varies considerably within the Persooniinae from the large drupes of *Garnieria spathulifolia* (2.5 cm long when fresh) to the small drupes of *Acidonia microcarpa* (0.5 cm long when fresh). However, on drying, the mesocarp shrinks: in some (e.g., *P. quinquenervis*) it shrinks relatively little while in others (e.g., *P. chapmaniana*) it shrinks considerably. To avoid confusion I have omitted measurements of the whole drupe from the species descriptions in favour of pyrene measurements, which are not altered by drying.

Pyrene shape and size vary considerably within the Persooniinae. Pyrene shape varies even more than drupe shape especially in the degree of lateral compression. In some cases, compression is so extreme that the pyrene is described as 'flattened' and plane-shape terms are used (e.g., the pyrene of *P. inconspicua* is described as flattened-obovate). Length and width measurements refer to (a) the length of the long axis and (b) the width of the widest axis perpendicular to the long axis.

The surface texture of the pyrene may be either conspicuously wrinkled by subtransverse grooves (as in *Garnieria spathulifolia*, *Toronia toru* or *Acidonia microcarpa*) or smooth.

In *Persoonia* species with two ovules per carpel, one- or two-seeded drupes may develop. In some species the number that develop is relatively constant so this information is included in the species descriptions. The embryos of most species in the Persooniinae possess more than two cotyledons, ranging from three (e.g., *P. graminea*) to nine (e.g., *P. saundersiana*). Gaertner (1807) was the first to report this observation, finding five cotyledons in the seeds of *Persoonia linearis*, on the strength of which he created the new genus *Pentadactylon*. Mueller (1882) and Fletcher (1908) later reported extensive surveys of cotyledon numbers in *Persoonia*, finding most of the species that they examined to be polycotylous.

An alternative interpretation of this feature is that there are two, deeply lobed cotyledons but the balance of available evidence does not support this idea. Firstly, in

most embryos, including those with an odd number of lobes, the lobes are of approximately equal size. Consequently, in a three-lobed embryo one cotyledon would have to be twice the size of the other if there were only two cotyledons present; in a five-lobed embryo, one would have to be one and a half times the size of the other and so on. Such behaviour seems unlikely. Secondly, if there are only two cotyledons per embryo, one might expect a basal division of the provascular trace into two cotyledon traces, followed by a more distal division of each into lobe traces. I checked this possibility by serially sectioning a number of embryos and consistently found that each lobe always possesses a single provascular trace and that these diverge basally from a single point. Cotyledon number could be useful in identifying fruiting specimens and is thus included in the species descriptions.

Format of descriptions

The format that I have used in the species descriptions is perhaps unorthodox in that punctuation is used in a rigidly formal manner to delimit pieces of information at particular hierarchial levels. Commas are used to delimit characters but are never used to separate alternative states where more than two are represented in the variation of a species. If each species description is considered the analogue of a single row in a data matrix, and each character a column, then commas, semicolons and full stops are analogous to the vertical lines dividing columns. This approach results in a decrease in 'readability' but an increase in the ease of data retrieval. I have attempted, as far as possible, to make all descriptions comparable with one another.

Cited specimens are grouped geographically according to Beard's (1980) phytogeographical regions of Western Australia, to pastoral districts of the Northern Territory (Chippendale 1972) and to Queensland pastoral districts (McLean 1886).

Typification

Most species of Persooniinae were named before the advent of the holotype as a formal concept. In such cases it seems wisest to treat all duplicates of collections cited in a protologue as syntypes from among which a suitable lectotype may be retrospectively designated. In choosing the most suitable lectotype from a collection of syntypes, I have limited my choice to material that is likely to have been used by the original author in preparing the original description. In making each choice I have preferred a sheet annotated by the original author, or material from his personal herbarium (if such exists).

Where more than one duplicate specimen is mounted on the same sheet, I have generally designated the most complete specimen (often the largest) as lectotype.

The case of Carl Meisner's types warrants special mention. Meisner worked on a variety of collections (Stafleu & Cowan 1981) and apparently took small pieces from many of the specimens that he examined, for incorporation in his own herbarium. Often he cited the collections that he used, but he did not always do so. The small specimens in Meisner's herbarium (now part of NY) are generally annotated by Meisner and I have designated these as lectotypes in preference to unannotated specimens from the European herbaria in which he worked.

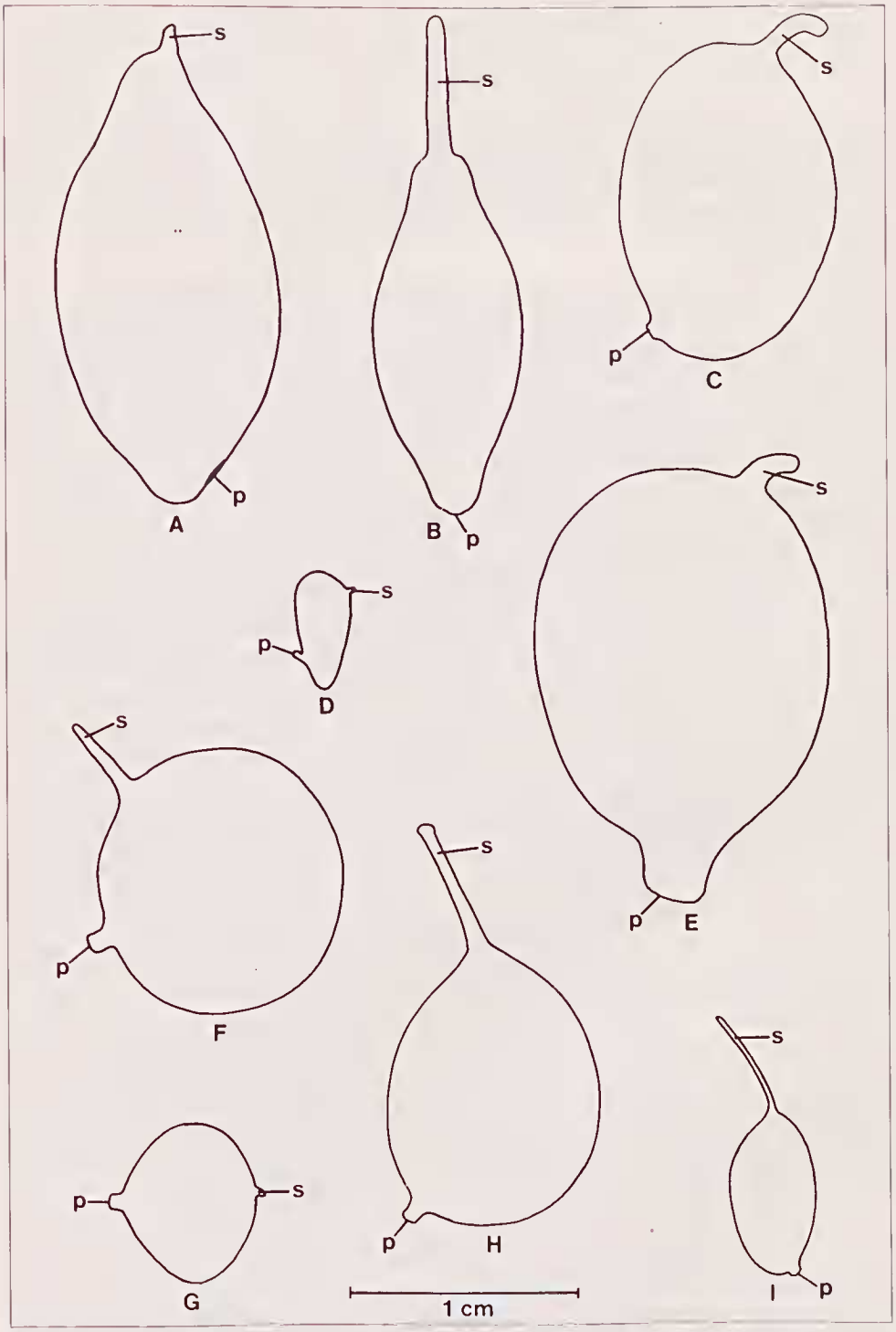

Figure 12. Lateral views of the drupes of some species of *Persoonia*. **A**, *P. teretifolia* (*P.H. Weston 240*); **B**, *P. quinquenervis* (*P.H. Weston 141*); **C**, *P. stricta* (*A.C. Burns 2*); **D**, *P. brevirhachis* (*K. Newbey 1034*); **E**, *P. falcata* (*K.F. Kenneally s.n., 30 Dec 1980*); **F**, *P. longifolia* (*P.H. Weston 261*); **G**, *P. inconspicua* (*R.D. Royce 6653*); **H**, *P. helix* (*P.H. Weston 352*); **I**, *P. micranthera* (*P.H. Weston 230*). Labels: p - point of attachment, s - remains of style.

Taxonomy

Proteaceae

Subfamily Persoonioideae *L.A.S Johnson & B.G. Briggs* (Johnson & Briggs 1975: 170)

Tribe Persoonieae *Rchb.* (Reichenbach 1828: 81)

Subtribe Persooniinae *L.A.S. Johnson & B.G. Briggs* (Johnson & Briggs 1975: 170)

Type genus: *Persoonia*

Shrubs to small trees with or without lignotuber, with fire-tolerant or fire-sensitive trunk or rarely trees to 15 m high or herbs. *Proteoid roots* absent (Purnell 1960, Lee 1978). *Bark* usually compact and smooth to fissured but occasionally compact and corky or lamellose and flaky. *Hairs* 3-celled, uniseriate; terminal cell unbranched, elongated, acute. *Leaves* alternate or rarely opposite or ternate, sometimes crowded, simple, entire, with short clasping base, usually without clearly-defined petiole, patent to erect, often curved upwards or rarely curved downwards, symmetrical to prominently asymmetrical, often twisted, sometimes pungent, soft and flexible to leathery and rigid, flat to terete, often with one or more longitudinal grooves or ridges, dorsiventral or similifacial; venation brochidodromous or acrodromous or parallelodromous or hyphodromous; fibre bundles of some veins sometimes extending to epidermis. *Inflorescences* racemose or spicate, not aggregated, terminal or axillary, auxotelic or anauxotelic, usually basitonic or rarely mesotonic or acrotonic, 1–100-flowered; rachis to 45 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, anteroposterior, regular or irregular, erect to pendulous, hermaphrodite. *Tepals* usually yellow but sometimes green or cream or with reddish markings, glabrous to densely hairy on outside, glabrous on inside or with marginal rows or patches of (often hair-like) papillae, free but usually coherent towards base, sometimes with conspicuous lateral flaps; dorsal tepal ± narrow-oblong or ± lanceolate or ± oblanceolate, often constricted below anthers, truncate at base; lateral tepals equal to dorsal tepal or slightly to prominently asymmetrical; ventral tepal equal to dorsal tepal or slightly to prominently saccate below ventral anther. *Staminal filaments* entirely adnate to tepals or free at tips. *Anthers* yellow to white or rarely green, free or basally adnate to tepals or rarely ventral anther wholly adnate to ventral tepal, introrse or sublatrorse; connective narrower than or wider than loculi, often elongated beyond loculi forming an appendage. *Pollen* triporate, isopolar to markedly subisopolar (Feuer 1986). *Gynoecium* about as long as stamens and exserted or about half length of stamens and ± straight with incurved tip or about half length of stamens and hooked downwards so that tip sits in pouch of ventral tepal below ventral anther; ovary glabrous or hairy, sessile or shortly stipitate; style not modified as a pollen presenter, sometimes with 8 prominent longitudinal ridges; ovules 1–7, orthotropous, pendulous to subpendulous, apical to subapical. *Hypogynous glands* free, short, thick, 4 or 2 with dorsal pair sometimes much reduced or absent. *Fruit* a 1–7-seeded drupe; mesocarp thick, succulent throughout; endocarp sclerenchymatous, smooth or with subtransverse ribs, formed from proliferating inner epidermis of pericarp which penetrates between seeds if more than 1 develops (Strohschen 1986). *Seeds* straight or rarely crescentic, not winged; testa thin, brittle; endosperm present; cotyledons 2–9. *Chromosomes* metacentric to submetacentric, about 10–30 µm long; haploid number n=7 or rarely n=14 (Hair & Beuzenberg 1959, Ramsay 1963, Johnson & Briggs 1975).

Habitat: Most species grow in acidic, well-drained, sandy or stony, siliceous soils derived from sandstones, granites, metasediments, acid volcanics, alluvial and aeolian deposits. A few species grow in poorly drained, acidic soils, one (*Garnieria*

spathulifolia) on peridotite, and a few extend onto soils derived from shales, basalts and calcareous substrates. Most species grow in heath or dry sclerophyll woodland or dry sclerophyll forest but a few occur in wet sclerophyll forest and rainforest.

Flowering period: mostly late spring to summer.

Distribution: New Caledonia, New Zealand and the non-arid areas of Australia, with a few species occurring marginally inside the arid zone. Of the 101 known species, 43 occur in Western Australia and, of these, 42 are endemic.

Key to the Western Australian genera of Persooniinae

1 Anthers gently incurved; anther appendage gently incurved; ovary sessile; style exserted, incurved at the tip but otherwise ± straight; endocarp subtransversely ribbed ..... **Acidonia**

1* Anthers straight or recurved to revolute; anther appendage straight to recurved or absent; ovary shortly stipitate or rarely sessile; style not as above; endocarp smooth ..... **Persoonia**

Key to the Western Australian species of Persooniinae

1 Perianth zygomorphic; gynoecium about half length of stamens and hooked so that tip sits in pouch of ventral tepal below ventral anther

2 Bark lamellose-flaky, deeply fissured; leaves slightly to strongly falcate; tropical Western Australia, Northern Territory, Queensland .... **33. Persoonia falcata**

2* Bark smooth and compact though sometimes fissured or slightly flaky at base; leaves straight to slightly falcate; SW Western Australia

3 Hypogynous glands 2 or 4, dorsal pair being much reduced or absent; anthers white

4 Perianth moderately hairy

5 Leaves subterete, grooved underneath .... **34. Persoonia biglandulosa**

5* Leaves flat

6 Leaf margins recurved or revolute; flowers subtended by leaves; rachis 7–25 cm long ..... **35. Persoonia brachystylis**

6* Leaf margins not recurved; flowers mostly subtended by scale leaves; rachis up to 1 cm long ..... **36. Persoonia kararae**

4* Perianth glabrous to sparsely hairy

7 Leaves flat, without prominent parallel veins .... **37. Persoonia stricta**

7* Leaves dorsiventrally flattened with 2 or 4 grooves on both surfaces or ± triangular in cross-section with 2 grooves on both surfaces or ± triangular to ventrally plano-convex in cross-section without grooves or ± subterete with single groove underneath ..... **38. Persoonia saundersiana**

3* Hypogynous glands 4, equal; anthers yellow or yellow with white tips

8 Leaves terete though often wrinkled when dried; ventral tepal shallowly saccate ..... **39. Persoonia teretifolia**

8* Leaves subterete and grooved underneath or flat to compressed; ventral tepal deeply saccate

9 Leaves > 2.5 mm wide ..... **40. Persoonia comata**

9* Leaves < 2 mm wide

10 Tepals hairy; anthers yellow with white tips .... **41. Persoonia saccata**

10* Tepals glabrous; anthers yellow .... **42. Persoonia hakeiformis**

1* Perianth actinomorphic; gynoecium exserted, equal to stamens or slightly longer or shorter than them

11 Anther connective extending beyond loculi as an appendage

12 Widest leaves > 2 mm wide

13 Leaves opposite-decussate, broad-cordate, as wide as they are long, or wider ..... **13. Persoonia cordifolia**

13* Leaves alternate or sometimes opposite at the end of a season's growth, not cordate, longer than wide

14 Ovary densely hairy ..... **20. Persoonia trinervis**

14* Ovary glabrous

15 Longest leaves > 8 cm long

16 Tepals > 10 mm long; erect shrub or small tree to 5 m, with lamellose-flaky bark ..... **4. Persoonia longifolia**

16* Tepals < 5 mm long; erect to decumbent weak shrub to 0.6 m, with smooth bark ..... **16. Persoonia graminea**

15* Leaves < 8 cm long

17 Leaves mostly > 10 mm wide; inflorescences anauxotelic, terminal or occasionally subterminal; rachis 1–6 cm long; flowers subtended by scale leaves; plants prostrate .... **17. Persoonia micranthera**

17* Leaves < 10 mm wide; inflorescences auxotelic or sometimes anauxotelic but then usually axillary and rachis < 1 mm long; flowers subtended by scale leaves or leaves; plants erect to spreading

18 Tepals glabrous to sparsely hairy; inflorescences usually auxotelic, terminal to axillary; flowers subtended by scale leaves or leaves

19 Leaves without prominent parallel veins, often pungent, often narrow but never linear

20 Anther appendage 1.2–2 mm long, recurved through 90–180°; anther loculi introrse

21 Tepals moderately glandular-hairy on the outside, 9–13 mm long; pedicels moderately hairy, 3.5–9 mm long; young branchlets covered with incurved-patent hairs ..... **25. Persoonia spathulata**

21* Tepals glabrous to moderately covered in non-glandular hairs on the outside, 6.5–10 mm long; pedicels glabrous, 1.5–4.5 mm long; young branchlets covered with antrorsely spreading hairs ..... **26. Persoonia scabra**

20* Anther appendage 0.3–0.5 mm long, not recurved; anther loculi sublatrorse ..... **15. Persoonia flexifolia**

19* Leaves with 3–13 prominent parallel veins or without prominent parallel veins but then linear, not pungent

22 Anther appendage 0.4–1 mm long, recurved through < 90° ..... **27. Persoonia quinquenervis**

22* Anther appendage 1.4–2.8 mm long, recurved through 90–180° ..... **28. Persoonia striata**

18* Tepals moderately to densely hairy; inflorescences anauxotelic, axillary; flowers subtended by scale leaves

23 Pedicels obsolete; leaves with 3 prominent parallel veins on upper surface ..... **3. Persoonia rufiflora**

23* Pedicels 1.5–5 mm long; leaves without prominent parallel veins ..... **2. Persoonia brevirhachis**

12* Leaves < 2 mm wide

24 Ovary densely hairy

25 Tepals glabrous ..... **18. Persoonia chapmaniana**

25* Tepals moderately to densely hairy

26 Leaves concave and sometimes grooved along upper surface when dried but with no other grooves or prominent parallel veins; hairs mostly > 2 mm long ..... **31. Persoonia rudis**

26* Leaves subterete to compressed but not concave, with 6 prominent parallel veins; hairs < 2 mm long

27 Leaves pungent; ovary hairs appressed, concolorous ..... **23. Persoonia bowgada**

27* Leaves not pungent; ovary hairs antrorsely spreading, darker towards apex of ovary

28 Inflorescences 1–4-flowered; flowers subtended by scale leaves ..... **21. Persoonia angustiflora**

28* Inflorescences 1–20-flowered; flowers subtended by scale leaves and leaves ..... **22. Persoonia papillosa**

24* Ovary glabrous or rarely sparsely hairy

29 Style tip prominently incurved; anthers gently incurved; pyrene subtransversely ribbed ..... **Acidonia microcarpa**

29* Style tip straight or sinuous; anthers straight or recurved, at least at the tips; pyrene smooth

30 Anther appendage < 1 mm long, either not recurved or recurved < 90°

31 Leaves with recurved to revolute margins (sometimes subterete and grooved underneath); anthers white

32 Leaves without prominent veins, circular in cross-section but with longitudinal groove on undersurface; pedicels 1–2.5 mm long ..... **1. Persoonia inconspicua**

32* Leaves with 3 prominent veins on upper surface or at least somewhat angular in cross-section; pedicels obsolete ..... **3. Persoonia rufiflora**

31* Leaves without recurved to revolute margins; anthers yellow

33 Longest leaves > 2.5 cm long

34 Leaves pungent, scabrous, subterete with 5 prominent parallel veins separated by narrow grooves; ovules 2; inflorescences anauxotelic ..... **19. Persoonia pentasticha**

34* Leaves not pungent, smooth to scaberulous, if subterete then with 8 prominent parallel veins; ovule 1; inflorescences usually auxotelic ..... **27. Persoonia quinquenervis**

33* Longest leaves < 2.5 cm long

35 Leaves deeply concave to subterete and involute ..... **14. Persoonia dillwynioides**

35* Leaves flat to subterete but not involute

36 Leaves flat to slightly concave or convex, without prominent parallel veins, 1.8–3 mm wide; ovules 2 ..... **15. Persoonia flexifolia**

36* Leaves compressed to subterete, with 4 or 6 prominent parallel veins separated by narrow grooves, 0.6–1 mm wide; ovule 1 ..... **30. Persoonia acicularis**

30* Anther appendage > 1 mm long, recurved through 90–180°

37 Longest leaves > 5 cm long; tepals sparsely to moderately hairy ..... **24. Persoonia hexagona**

37* Leaves ≤ 5 cm long; tepals glabrous

38 Anther appendage filiform and often sinuate ..... **32. Persoonia filiformis**

38* Anther appendage obtuse or acute

39 Leaves pungent ..... **29. Persoonia sulcata**

39*Leaves sometimes sharp but never pungent ..... **28. Persoonia striata**

11*Anther appendage absent

40 Ovary moderately covered with appressed hairs; leaves 1.5–4 cm long, 1.5–2.5 mm wide ..... **9. Persoonia cymbifolia**

40*Ovary glabrous; leaves 0.5–20 cm long, 1–50 mm wide

41 Longest leaves > 2.5 cm long

42 Leaves pungent, subterete, 0.7–1.2 mm wide, with 5 narrow, longitudinal grooves; inflorescences anauxotelic ..... **19. Persoonia pentasticha**

42*Leaves not pungent, flat or dorsiventrally flattened, 1–50 mm wide, lacking longitudinal grooves; inflorescences auxotelic

43 Tepals moderately to densely covered with tawny to ferruginous hairs; bark lamellose-flaky ..... **4. Persoonia longifolia**

43*Tepals glabrous to densely covered with greyish hairs; bark smooth and compact or rough and corky

44 Widest leaves > 13 mm wide, soft and flexible ..... **5. Persoonia elliptica**

44*Widest leaves < 13 mm wide, leathery

45 Leaves twisted through 0.5–3 turns, 1.5–4 mm wide ..... **7. Persoonia helix**

45*Leaves twisted through < 0.5 of a turn or twisted up to 1 turn but then > 4 mm wide

46 Leaves 1–2.5 mm wide ..... **8. Persoonia pertinax**

46*Widest leaves 3–13 mm wide ..... **6. Persoonia coriacea**

41*Longest leaves < 2.5 cm long

47 Tepals densely hairy ..... **10. Persoonia leucopogon**

47*Tepals glabrous

48 Leaves spathulate to narrow-spathulate, not pungent ..... **12. Persoonia baeckeoides**

48*Leaves elliptical narrow-elliptical or narrow-oblong, pungent ..... **11. Persoonia pungens**

Acidonia

Acidonia L.A.S. Johnson & B.G. Briggs (Johnson & Briggs 1975: 175). Type: *A. microcarpa* L.A.S. Johnson & B.G. Briggs

Shrubs. *Leaves* alternate. *Inflorescences* axillary, anauxotelic, pantotonic. *Flowers* subtended by scale leaves. *Tepals* yellow, not constricted below anthers, glabrous on inside; lateral flaps absent. *Staminal filaments* entirely adnate to tepals. *Anthers* yellow, introrse, gently incurved; connective slightly wider than loculi; appendage

present, gently incurved. *Gynoecium* longer than stamens, exserted; ovary glabrous, sessile; style incurved at tip but otherwise ± straight; ovules 2. *Hypogynous glands* 4, equal. *Endocarp* subtransversely ribbed. *Seed* 1, straight; cotyledons 2.

Acidonia microcarpa (R. Br.) L.A.S. Johnson & B.G. Briggs

(Johnson & Briggs 1975: 175).

Basionym: *Persoonia microcarpa* R. Br. (Brown 1810a: 160, 1810b: 372); Sprengel (1825: 472); Meisner (1845: 531); Meisner (1856: 343); Bentham (1870: 387).

Linkia microcarpa (R. Br.) Kuntze (1891: 579)

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: in ericetis paludosis. (ubi v.v.)'

Lectotype (here designated): On a sheet labelled 'No. 3291 R. Brown In paludosis prope Princess Royal Harbour ad Portum Regis Georgii III Decr 1801'; annotated by Brown (BM, photo NSW). The specimen on the left-hand side of the sheet is designated lectotype. Isolectotypes: B, BM (photo NSW), K (photo NSW), NSW.

Erect, often spreading shrub with single main stem or with several to many stems branching near base, 0.6–3 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled greyish-brown. *Hairs* medium length, appressed to antrorsely spreading, greyish to mid-brown. *Branchlets* sometimes angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent after 1 or 2 years. *Leaves* alternate, linear, ± symmetrical, not twisted, prominently convex when fresh but becoming revolute when dried, acute to acuminate, not pungent, (1.8–)6–13 cm long, 0.7–1.7 mm wide, sometimes crowded at end of season's growth, mostly patent to suberect, often curved upwards and downwards so as to be sinuate, ± soft and flexible, not glaucous, concolorous, sparsely to densely hairy when immature, glabrescent when mature; venation hyphodromous; midvein obscure or evident on abaxial surface, obscure on adaxial surface; marginal veins absent; other veins obscure; epidermis smooth. *Scale leaves* triangular to narrow-triangular, obtuse or acute or acuminate, 1–5.5 mm long, 0.7–2 mm wide. *Inflorescences* axillary, anauxotelic, pantotonic, (1–)2–3(–4)-flowered; rachis to 0.1 cm long. *Flowers* subtended by scale leaves, regular, mostly held upright to subupright. *Pedicels* 2–5 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* lanceolate, truncate at base, not constricted below anthers, acute, 8–12 mm long, 1.7–2.6 mm wide, bright yellow, moderately hairy on outside, glabrous on inside; lateral flaps absent. *Filaments* adnate to tepals, 1–2 mm long, 1/6–1/10 as long as tepals. *Anthers* bright yellow, introrse, held close together and close to gynoecium from their bases to tips of appendages, gently incurved, free or adnate to tepals to lower 1/7 of loculi; connective slightly wider than loculi; loculi glabrous, 2.8–3.5 mm long; appendage rounded and dorsiventrally flattened, 0.6–1 mm long, 1/7–3/10 as long as loculi. *Gynoecium* longer than stamens, exserted, 7.5–9.5 mm long, glabrous; ovary distinctly contracted at base, conspicuously thicker than base of style; style incurved at tip but otherwise ± straight, not ridged, ± constant in thickness for most of its length but tapering abruptly at tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid and slightly compressed, smooth; long axis slightly oblique to point of attachment and style; pyrene compressed-ellipsoid, 4–4.5 mm long, c. 2.5 mm wide, subtransversely ribbed; seed 1; embryo straight; cotyledons 2.

Habitat: In peaty, poorly drained sand, surrounding bogs or creeks, usually in thicket or swamp-heath communities dominated by sedges and myrtaceous shrubs; in small populations.

Flowering period: October to December.

Distribution: (Fig. 13a) Darling district: Margaret River to Albany, within 50 km of the coast.

Conservation status: 3RC– (Briggs & Leigh 1988, as *Persoonia microcarpa*).

Variation: This is a very coherent species in which variation between individuals seems to be no greater than that within individuals.

Discussion: This species is distinguished from species of *Persoonia* most readily by the exserted gynoecium with incurved tip and with a sessile ovary which is conspicuously thicker than the base of the style. Other characters which distinguish it are the wide, gently incurved, leaf-like, yellow, introrse anthers and the small drupes (which retain the characteristic style) with subtransversely ribbed pyrenes and seeds with 2 cotyledons.

Selected specimens (27 examined): Western Australia: Darling: Nillup, on Nannup-Karridale road, *R.D. Royce 3018*, Oct 1948 (PERTH); 16 km NW of Mt Manypeaks, *K. Newbey 2736*, Nov 1967 (PERTH); King George Sound, *J.H. Maiden s.n.*, Nov 1909 (NSW); Scott River, *E. Wittwer 2256*, Dec 1978 (PERTH); 11.1 km S of Northcliffe on the road to Windy Harbour, 34° 43' S, 116° 05' E, *P.H. Weston 218*, Dec 1980 (SYD, NSW, PERTH); Bow River, *S.W. Jackson s.n.*, Nov 1912 (NSW, PERTH).

Persoonia

Persoonia Sm. (Smith 1798: 215), nomen conservandum (Briquet 1935). Lectotype: *P. lanceolata* Andr. (Briquet 1935).

nec *Persoonia* Willd. (Willdenow 1799: 331) = *Carapa* Aublet (Meliaceae).

nec *Persoonia* Michx. (Michaux 1803: 104) = *Marshallia* Schreb. (Asteraceae).

Linkia Cav. (Cavanilles 1797: 61) nom. rej. vs. *Persoonia* Sm.. Type: *L. levis* Cav. (*Persoonia levis* (Cav.) Domin).

Pentadactylon C.F. Gaertn. (Gaertner 1807: 219). Type: *P. angustifolium* C.F. Gaertn. (*Persoonia linearis* Andr.).

Pycnonia L.A.S. Johnson & B.G. Briggs (Johnson & Briggs 1975: 175). Type: *P. teretifolia* (R. Br.) L.A.S. Johnson & B.G. Briggs (*Persoonia teretifolia* R. Br.).

Shrubs to small trees or rarely trees to 15 m high or herbs. *Leaves* alternate or rarely opposite or ternate. *Inflorescences* terminal or axillary, auxotelic or anauxotelic, usually basitonic or pantotonic or rarely mesotonic or acrotonic. *Flowers* subtended by scale leaves or reduced leaves or leaves. *Tepals* usually yellow or sometimes green or white or with reddish markings, often constricted below anthers, glabrous on inside or with marginal rows or patches of (often hair-like) papillae; lateral flaps present or absent. *Staminal filaments* entirely adnate to tepals or free at tips. *Anthers* yellow to white or rarely green, introrse to sublatrorse, straight to strongly recurved; connective narrower or wider than loculi; appendage absent or present and straight to strongly recurved. *Gynoecium* about as long as stamens and exserted or about half length of stamens and hooked downwards so that tip sits in pouch of ventral tepal below ventral anther; ovary glabrous or hairy, shortly stipitate or apparently sessile; ovules 1 or 2. *Hypogynous glands* 4 and equal or with dorsal pair sometimes much reduced or 2. *Endocarp* smooth. *Seed* 1 or 2, straight or rarely crescentic; cotyledons 2–9.

The species treatments are ordered so as to group species that clustered in putatively monophyletic groups in my cladistic analysis of the Persooniinae (Weston 1983).

1. Persoonia inconspicua *P.H. Weston*, **sp. nov.**

Folia (0.9–)2–6.5 cm longa, 0.7–1.3 mm lata, linearia, subteretia infra canaliculata. Inflorescentiae axillares anauxotelicaeque. Flores regulares. Gynoecium exsertum, glabrum, stamina superans. Ovarium latum, stipitatum. Appendix antherae globula vel oblonga, 0.3–0.6 mm longa, non recurvata.

Holotype: Western Australia: Coolgardie: 6 km N of Hicky Ricken Soak, c. 60 km N of Bullfinch, *P.G. Wilson 8766*, 24 Aug 1970 (PERTH). Isotype: SYD.

Erect, often spreading shrub with single main stem or with several to many stems branching near base, 0.5–2.5 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely speading, greyish to pale brown. *Branchlets* terete, densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, not twisted, subterete and grooved underneath, acute to acuminate, not pungent, (0.9–)2–6.5 cm long, 0.7–1.3 mm wide, often crowded at end of season's growth, mostly suberect to erect, often curved upwards slightly, leathery and rigid to rather flexible, not glaucous, concolorous, moderately to densely hairy when immature, glabrescent when mature; venation hyphodromous; marginal veins absent; epidermis papillose and scaberulous to scabrous. *Scale leaves* ovate or triangular or narrow-triangular, acute to acuminate, 0.5–2.2 mm long, 0.3–0.7 mm wide. *Inflorescences* axillary on leafy shoots or ramiflorous, anauxotelic, pantotonic, 1–2(–3)-flowered; rachis to 0.01 cm long. *Flowers* subtended by scale leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 1–2.5 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to ± lanceolate, truncate at base, not constricted below anthers, acute, 8–10.5 mm long, 1–1.3 mm wide, greenish yellow, glabrous to moderately hairy on outside, glabrous on inside except for small

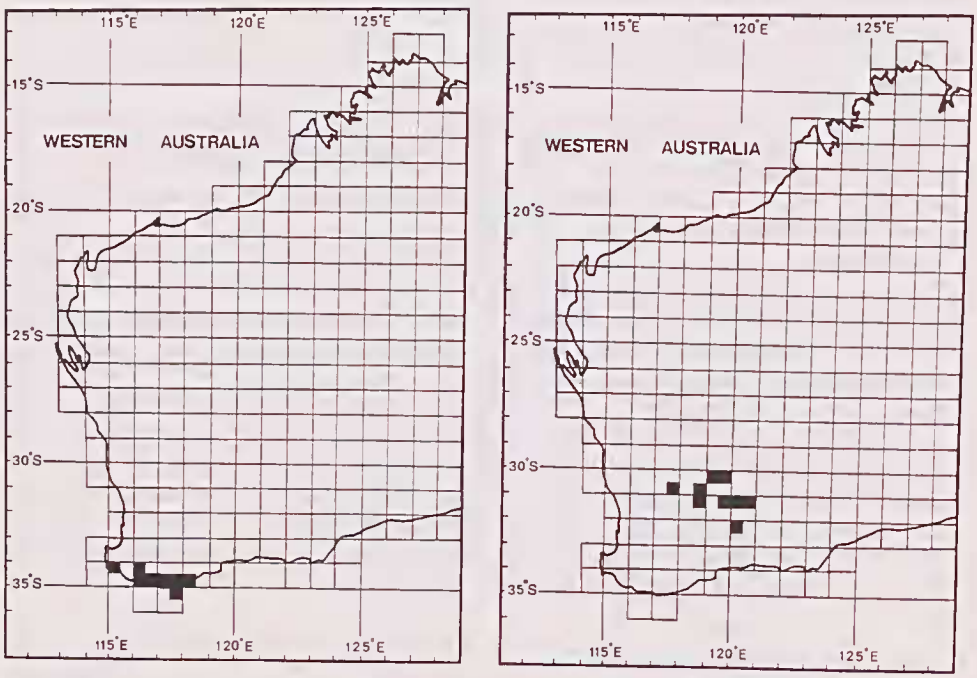

Figure 13. Distributions of **a**, *Acidonia microcarpa* and **b**, *Persoonia inconspicua*.

marginal patches of papillae near base of each anther; lateral flaps absent. *Filaments* adnate to tepals except at tips, 2–3.3 mm long, 1/4–2/5 as long as tepals. *Anthers* white, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; connective narrower than loculi; loculi glabrous, 2.5–4.2 mm long; appendage ± globular to ± oblong, 0.3–0.6 mm long, 1/7–1/12 as long as loculi. *Gynoecium* longer than stamens, exserted, 6–9 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight or bent sideways then upwards at base, not ridged, often capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* compressed-obovoid, smooth; long axis prominently oblique to perpendicular to stipe, prominently oblique to perpendicular to style; pyrene flattened-obovate, 6–8 mm long, 3.5–4 mm wide, smooth; seed 1; embryo straight; cotyledons 2.

Derivation of epithet: From the Latin *inconspicuus*, inconspicuous, in reference to the inconspicuous, small, greenish flowers.

Habitat: In yellow sand or sandy loam, in heath or mallee-heath communities; usually in small populations or occurring as isolated individuals.

Flowering period: June to September.

Distribution: (Fig. 13b) Avon, Roe and Coolgardie districts: an area roughly bounded by Cowcowing Lakes, Mt Jackson, Queen Victoria Rock and the Johnston Lakes.

Conservation status: Not rare.

Variation: This is a coherent species showing slight between-population differences in leaf width, tepal length and the density of hairs on the outside of the tepals. None of these characters shows an obvious trend across the distribution.

Discussion: *P. inconspicua* may be distinguished from all other species by a combination of the following characters: (a) leaves subterete and grooved underneath (i.e. revolute), (b) anthers white, sublatrorse, with ± globular to ± oblong appendages, (c) flower regular, (d) gynoecium glabrous, (e) style tip straight, (f) drupe elongated, with a prominently subterminal style and sub-basal stipe, (g) embryo with two cotyledons. It closely resembles one extreme of variation within *P. rufiflora* (that end of the cline including the type of *P. scabrella*). However, *P. inconspicua* may be distinguished from that form by its unridged leaves, longer pedicels and less hairy flowers. This species has been misidentified frequently as *Persoonia microcarpa* (i.e. *Acidonia microcarpa*) but is readily distinguished from that species by characters (a) (leaves convex when fresh in *A. microcarpa*), (b) (anthers yellow, introrse, with rounded and dorsiventrally flattened appendages in *A. microcarpa*), (c) (style tip incurved in *A. microcarpa*), and (f) (drupe ellipsoid, with subterminal style and sub-basal connection to receptacle in *A. microcarpa*). *P. inconspicua* was first collected only in 1961, apparently because most of its distribution was remote and relatively unexplored. No doubt further collections will extend the known distribution of this species.

Selected specimens (13 examined): Avon: Bencubbin, *R.D. Royce 6653*, Sep 1961 (PERTH); Noongar, 31° 20' S, 118° 58' E, *M.D. Crisp 6571*, Jul 1981 (CBG); 6.8 km E of Carrabin, 31° 23' S, 118° 45' E, *R. Coveny 8360 & B. Haberley*, Sep 1976 (NSW). Coolgardie: 20 km NE of Bungalbin Hill, *K. Newbey 8988*, Sep 1981 (PERTH); 20 km W of Boorabbin, *K. Newbey 8372*, Jul 1981 (PERTH); 3.9 km W of Yellowdine, 31° 18' S, 119° 36' E, *P.H. Weston 140*, Nov 1980 (SYD, NSW, PERTH); SW of Queen Victoria Rocks, *A.S. George 8048*, Sep 1966 (PERTH). Roe: 39.5 km E of Southern Cross- Lake King road on Hyden–Norseman road, 32° 18' S, 120° 09' E, *P.H. Weston 343*, Dec 1980 (SYD, PERTH).

2. Persoonia brevirhachis *P.H. Weston*, **sp. nov.**

Folia (0.8–)2–5 cm longa, 2.5–5.5 mm lata, plerumque anguste spathulata vel oblanceolata. Inflorescentiae axillares anauxotelicaeque. Flores regulares, in pedicellis 1.5–5 mm longis affixi. Gynoecium exsertum, glabrum, stamina superans. Ovarium latum, stipitatum. Filamenta staminum 2–2.5 mm longa. Appendix antherae globula, 0.4–0.6 mm longa.

Holotype: Western Australia: Roe: About 31 km S of Lake Grace on road to Pingrup, 33° 23' S, 118° 30' E, *D.B. Foreman 757*, 17 Sep 1984 (PERTH). Isotypes: CANB, MEL, NSW.

Erect, often spreading shrub with single main stem or with several to many stems branching near base, 0.3–2 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish to pale brown. *Branchlets* sometimes slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, mostly narrow-spathulate to oblanceolate or occasionally linear-spathulate or linear-oblanceolate, symmetrical, not twisted, flat but with recurved to revolute margins, acute or acuminate or obtuse or mucronate, not pungent, (0.8–)2–5 cm long, 2.5–5.5 mm wide, often crowded at end of season's growth, mostly suberect to erect, often curved upwards slightly, leathery and rigid, often rather glaucous, concolorous, moderately to densely hairy when immature, glabrescent when mature; venation acrodromous; midvein evident on adaxial surface, obscure on abaxial surface; marginal veins obscure; intramarginal and other veins evident or obscure on adaxial surface, obscure on abaxial surface; epidermis papillose and scabrous. *Scale leaves* triangular to narrow-triangular, acute, 0.8–1.1 mm long, 0.2–0.4 mm wide. *Inflorescences* axillary on leafy shoots or ramiflorous, anauxotelic, pantotonic, 1–2-flowered; rachis to 0.01 cm long. *Flowers* subtended by scale leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 1.5–5 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-elliptic to lanceolate, truncate at base, not constricted below anthers, acute, 6.5–9 mm long, 1–1.5 mm wide, yellow to greenish yellow, moderately to densely hairy on outside, glabrous on inside or with small marginal patches of papillae below point of attachment of stamens; lateral flaps absent. *Filaments* adnate to tepals except at their tips, 2–2.5 mm long, 1/4–1/3 as long as tepals. *Anthers* white, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; connective narrower than loculi; loculi glabrous, 2.5–3.2 mm long; appendage ± globular, 0.4–0.6 mm long, 1/5–1/7 as long as loculi. *Gynoecium* longer than stamens, exserted, 5.5–8 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight or bent sideways then upwards at base, not ridged, sometimes capitate but otherwise constant in thickness or slightly thickened from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* obovoid, smooth; long axis prominently oblique to perpendicular to stipe, prominently oblique to perpendicular to style; pyrene ellipsoid to obovoid, 4.5–5.5mm long, 2–2.5 mm wide, smooth; seed 1; embryo straight; cotyledons 2.

Derivation of epithet: From the Latin *brevis*, short, and *rhachis*, in reference to the very short or obsolete inflorescence rachis.

Habitat: In yellow sand over laterite, in heath or mallee-heath; locally common.

Flowering period: August to October.

Distribution: (Fig. 14a) Roe district: between Lake Grace, Newdegate and Ravensthorpe.

Conservation status: 2E (Briggs & Leigh 1988, as *Persoonia* sp.9).

Variation: This is a coherent species with only minor variation between individuals in leaf shape and style morphology. This variability does not appear to be ecologically or geographically correlated.

Discussion: *P. brevirhachis* is distinguished by the following combination of characters: leaves narrow-spathulate to oblanceolate or occasionally linear-spathulate or linear-oblanceolate, (0.8–)1.5–5 cm long, 2.5–5.5 mm wide, without prominent ridges, flat with recurved to revolute margins; flowers regular; anther appendages ± globular. It closely resembles *P. rufiflora* and *P. inconspicua* but is distinguished from them by the abovementioned leaf characters. It has been misidentified persistently as *P. scabra*, a quite different species, presumably as a result of Brown's brief protologue of *P. scabra*, and the inaccessibility of type material. It is distinguished easily from that species by differences in leaf characters as well as its white, sublatrorse anthers.

Selected specimens (12 examined): Roe: 25 km E of Lake Grace, 33° 06' S, 118° 44' E, *K. Newbey 9536*, Sep 1982 (PERTH); 2.0 km W of Newdegate, 33° 06' S, 118° 59' E, *P.H. Weston 253*, Dec 1980 (SYD); 236 mile peg on Newdegate road, *E. Wittwer 166*, Sep 1963 (KPBG). Eyre: 20 miles [32 km] NW of Ravensthorpe, *C.A. Gardner 1765*, Sep 1925 (PERTH).

3. Persoonia rufiflora *Meisn.*

Meisner (1855: 72, 1856: 332); Bentham (1870: 389).

Linkia rufiflora (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'Drummond, coll. vi. n. 176.'

Lectotype (here designated): a sheet annotated by Meisner '*Persoonia rufiflora* nob. (10.Nov.1854.) Interior North of Swan River A. 1850-51 legit. Drummond Coll. VI (accepta 1854.) N° 176! D.am. Shuttl. Nov. 1854.' (NY). Isolectotypes: BM, CGE, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, NSW (2 sheets), PERTH (n.v.).

P. scabrella Meisn. (Meisner 1855: 72, 1856: 33); Bentham (1870: 388). *Linkia scabrella* (Meisn.) Kuntze (Kuntze 1891: 579). Type citation: 'Drummond, coll. vi. n. 177.' **Lectotype (here designated):** a sheet labelled by Meisner '*Persoonia scabrella* nob. A. 1850-51. legit. Drummond, Coll. VI. (accepta 1854.) N° 177! D.am. Shuttl. Nov. 1854.' (NY). Isolectotypes: BM, CGE, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, NSW, PERTH.

Erect, sometimes spreading shrub, with single main stem or with several to many stems branching near base, 0.5–2.5 m high, regenerating after disturbance from lignotuber, without spreading or extensive underground stems and with thickened taproot. *Bark* smooth but sometimes fissured at base, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading or curly, greyish to ferruginous. *Branchlets* terete, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, oblanceolate to linear, usually symmetrical, not twisted, flat but with recurved or revolute margins to deeply convex or subterete and grooved underneath but always with 3 ridges on adaxial surface, acute or acuminate or obtuse or mucronate, not pungent, (0.8–)2–4.5 cm long, 0.7–8 mm wide, often crowded at end of season's growth, mostly suberect to erect, often curved upwards slightly or rarely curved downwards, leathery and rigid or slightly flexible, sometimes slightly glaucous and occasionally more so on abaxial surface, otherwise concolorous, moderately to densely hairy when immature, glabrescent when mature; venation acrodromous to parallelodromous; midvein prominent on adaxial surface, obscure

on abaxial surface; marginal veins obscure to evident; intramarginal veins prominent on adaxial surface, obscure on abaxial surface; other veins obscure; epidermis smooth to papillose and scabrous. *Scale leaves* ovate or triangular to narrow-triangular, acute to obtuse, 0.5–1.5 mm long, 0.3–0.7 mm wide. *Inflorescences* axillary on leafy shoots or ramiflorous, anauxotelic, pantotonic, 1 or rarely 2-flowered; rachis to 0.01 cm long. *Flowers* subtended by scale leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* obsolete. *Tepals* ± narrow-oblong to lanceolate, truncate at base, acute, 6.5–10 mm long, 1–1.5 mm wide, greenish-yellow, densely hairy on outside, glabrous on inside except for small marginal patches of papillae near base of each anther; lateral flaps absent. *Filaments* adnate to tepals except at tips, 2–3 mm long, 1/4–2/5 as long as tepals. *Anthers* white, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; connective narrower than loculi; loculi glabrous, 2–4 mm long; appendage ± globular, 0.2–0.4 mm long, 1/6–1/12 as long as loculi. *Gynoecium* longer than stamens, exserted, 5–8 mm long, glabrous or rarely sparsely hairy; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight or bent sideways then upwards at base, not ridged, often capitate but otherwise ± constant in thickness or thickening slightly from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* reniform or ellipsoid to obovoid and compressed, smooth; long axis prominently oblique to perpendicular to stipe, prominently oblique to perpendicular to style; pyrene compressed-ellipsoid, c. 6 mm long, c. 2 mm wide, smooth; seed 1; embryo straight; cotyledons 2.

Habitat: In yellow or white sand or sandy loam, often over laterite or on ironstone breakaways, in low heath or mallee-heath to mallee-woodland communities; locally common or sometimes in small populations or occurring as isolated individuals.

Flowering period: June to September.

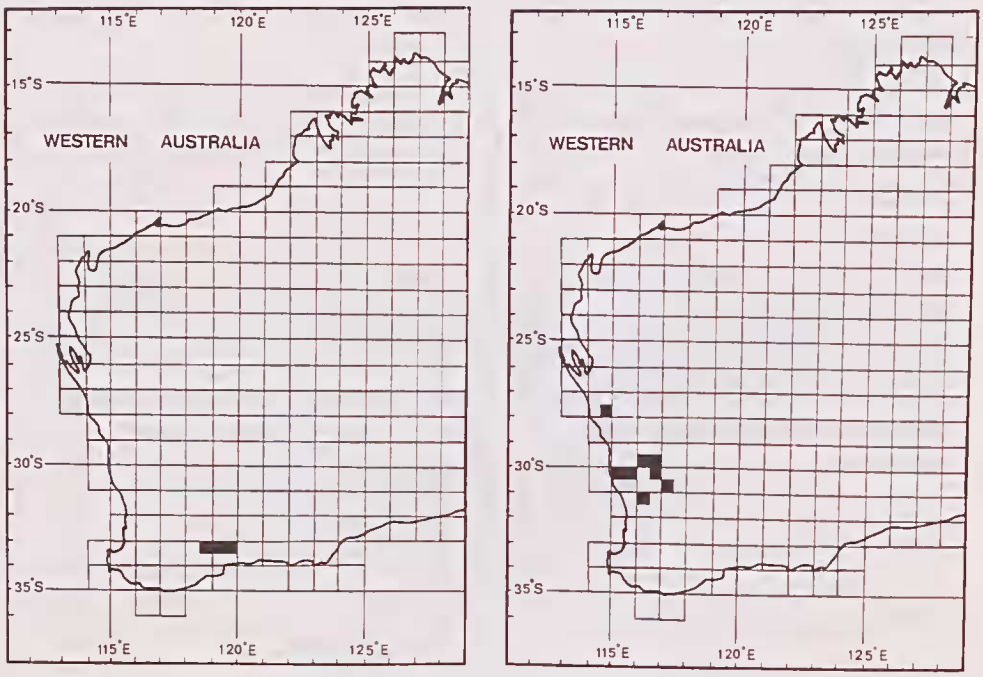

Figure 14. Distributions of **a**, *Persoonia brevirhachis* and **b**, *Persoonia rufiflora*.

Distribution: (Fig. 14b) Irwin, Darling and Avon districts: Kalbarri National Park, SW to the Mogumber–Minnivale area.

Conservation status: Not rare.

Variation: *P. rufiflora* shows geographically correlated variation in leaf morphology between populations. The extremes of variation may be characterised as follows. Northeastern (Maya area): leaves oblanceolate, 6–8 mm wide, flat with recurved margins. Southwestern (Badgingarra–Mogumber area): leaves linear, less than 1 mm wide, subterete with revolute margins touching one another. The whole range of intermediates between these extremes is found in the intervening areas. Two collections have also been made much farther north, in Kalbarri National Park and these are intermediate in leaf form. Meisner (1855) described the extreme forms as two different species, *P. rufiflora* and *P. scabrella*, but collections since then have blurred the distinction so that there seems now to be a morphocline connecting the two species and I have united Meisner's species. Other characters such as indumentum type and style morphology vary within and between populations but do not seem to be geographically correlated.

Discussion: *P. rufiflora* may be distinguished by a combination of the following characters: (a) leaves with 3 prominent ridges on the upper surface (b) pedicels obsolete (c) flowers regular (d) anthers white, sublatrorse with ± globular appendages. It closely resembles *P. inconspicua* and *P. brevirhachis* but differs from them in characters (a) and (b) above.

Selected specimens (24 examined): Irwin: 27 miles [44 km] SE of Kalbarri, *R. Filson 8664*, Sep 1966 (PERTH); 15 miles [24 km] N of Badgingarra, *A.S. George 6746*, Aug 1965 (NSW, PERTH 2 sheets). Darling: Mogumber, *H. Steedman s.n.*, Feb 1935 (PERTH). Avon: 3 miles [5 km] S of Maya, *H. Demarz 1436*, Aug 1969 (KPBG, PERTH); Manmanning rubbish tip, 30° 51' S, 117° 05' E, *P.H. Weston 316*, Dec 1980 (SYD); 1 km E of Calingiri, *B.H. Smith s.n.*, Jul 1969 (PERTH).

4. Persoonia longifolia *R. Br.*

Brown (1810a: 164, 1810b: 374); Sprengel (1825: 472); Meisner (1845: 533, 1856: 343); Bentham (1870: 390); Weston (1987: 350).

Linkia longifolia (R. Br.) Kuntze (Kuntze 1891: 579).

Type citation: 'In Novae Hollandiae orâ australi: Lewins Land: in collibus saxosis. (ubi v.v.)'

Lectotype (here designated): On a sheet labelled 'No. 3301. R. Brown. King George III Sound'; annotated by Brown (BM, photo NSW). The specimen on the left-hand side of the sheet is designated lectotype. Isolectotypes: E, K.

P. articulata R. Br., (Brown 1810a: 164, 1810b: 374); Sprengel (1825: 473); Meisner (1856: 342); Bentham (1870: 390). *Linkia articulata* (R. Br.) Kuntze (Kuntze 1891: 579). Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: in collibus saxosis. (ubi v.v.)' **Lectotype (here designated):** On a sheet labelled 'R. Brown No. 3300 In fruticetis ad latera collium prope Portum Regis Georgii III Dec. 1801.'; annotated by Brown (BM, photo NSW). The specimen on the right-hand side of the sheet is designated lectotype. Isolectotypes: K, NSW.

P. drummondii Lindl. (Lindley 1840: 35). Type citation: none given. **Lectotype (here designated):** a specimen labelled 'Swan River, Drummond, 1839,' (CGE, photo NSW). Isolectotypes?: FI, K.

Erect shrub or small tree, usually with single main trunk but often with many small suckers at base, 1–5 m high, regenerating after disturbance from epicormic shoots or

lignotuber: underground parts not known. *Bark* lamellose with outside layers dark brown or grey and inside layers reddish purple, flaky. *Hairs* short to medium length, appressed to antrorsely spreading, mid-brown to ferruginous. *Branchlets* angular when immature but becoming terete when mature, moderately hairy when young but glabrescent with age. *Leaves* alternate, oblanceolate or narrow-elliptical or linear, slightly to prominently asymmetrical, usually twisted at base so that most of laminae are held in ± vertical plane but occasionally not twisted and held ± horizontally, flat or sometimes slightly convex or margins sometimes slightly recurved, acute to acuminate, not pungent, (2.5–)8–20 cm long, 2–16 mm wide, sometimes crowded at end of season's growth, mostly patent to suberect, not usually curved in dorsiventral plane, soft and flexible, not glaucous, concolorous or occasionally slightly paler on undersurface, glabrous to sparsely hairy when immature, glabrescent when mature; venation ± brochidodromous to parallelodromous; midvein prominent on adaxial surface, less so or evident on abaxial surface; marginal veins absent; other veins evident on adaxial surface, obscure on abaxial surface; epidermis smooth. *Scale leaves* triangular to narrow-triangular, acute, 1–6.5 mm long, 0.7–1.9 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic or pantotonic, (1–)7–30-flowered; rachis (0–)1–7 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 4–12 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong, slightly constricted below anthers, acute to acuminate, 10–16 mm long, 1.4–1.8 mm wide, bright yellow, moderately hairy on outside, glabrous on inside or with marginal rows of papillae on proximal 1/2; lateral flaps absent. *Filaments* adnate to tepals, 2.8–5 mm long, 1/4–3/10 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free or adnate to tepals to lower 1/5 of loculi; connective narrower than loculi; loculi glabrous, 4.3–7.5 mm long; appendage absent or present and ± oblong, to 1 mm long, to 1/8 as long as loculi. *Gynoecium* about as long as stamens, exserted, 8–13 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight, not ridged, capitate but otherwise ± constant in thickness or tapering slightly from base to tip; abscission zone 1/3–2/3 way up stipe or very rarely basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* compressed-reniform, smooth; long axis prominently oblique to stipe, prominently oblique to style (axis between stipe and style crescentic); pyrene compressed-reniform to lenticular, 7.5–10 mm long, 6–7.5 mm wide, smooth; seed 1; embryo crescentic; cotyledons 2.

Habitat: In grey or yellow sand to sandy loam or laterite, frequently as an understorey shrub or tree in woodland or forest dominated by *Eucalyptus marginata* and/or *E. calophylla* or less frequently in *Agonis flexuosa* woodland, often associated with *Persoonia elliptica*; common throughout its range.

Flowering period: November to February.

Distribution: (Fig. 15a) South-western Australia: Perth to Albany, within 70 km of the coast.

Conservation status: Not rare (*Persoonia articulata* coded as ?3R by Briggs & Leigh (1989), on the basis that it might prove to be specifically distinct, but see below).

Variation: *P. longifolia* varies considerably in leaf shape and dimensions and in anther appendage length. However, this variability does not appear to be correlated with distributional or habitat differences. Of particular interest are the individuals with wide, horizontally-held, nearly symmetrical leaves, which until recently (Weston 1987) have been regarded as a distinct species, *P. articulata* R. Br., but which are

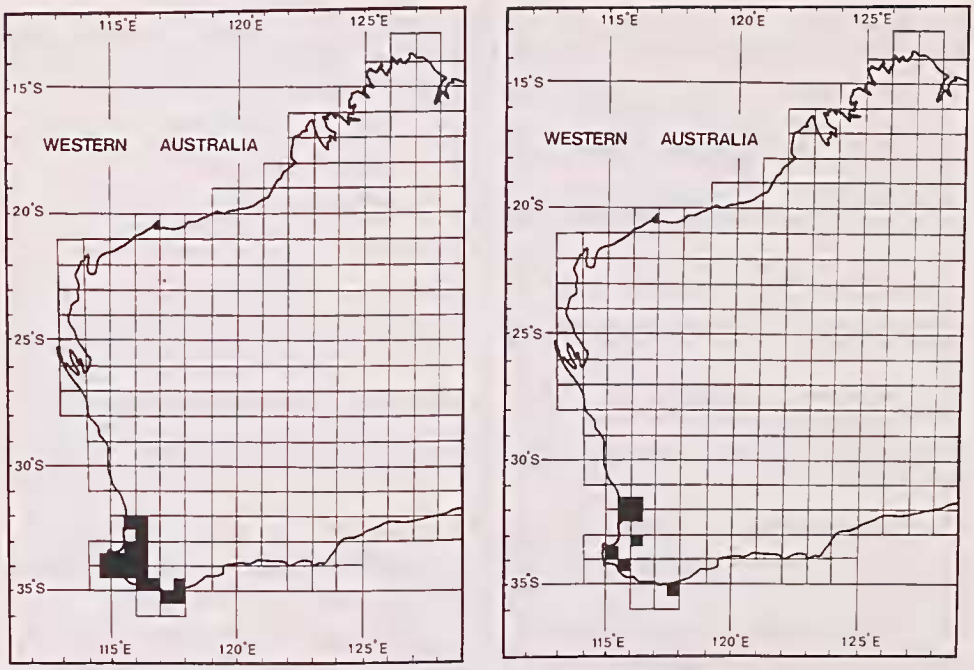

Figure 15. Distributions of **a**, *Persoonia longifolia* and **b**, *Persoonia elliptica*.

indistinguishable from *P. longifolia* in all other characteristics. I have seen *'P. articulata'* once in the field where I found a single individual plant (*P.H. Weston 214*) growing amongst a large population of typical *P. longifolia* with narrow, prominently asymmetrical leaves held in a vertical plane (*P.H. Weston 215, 216*; all SYD). The differences between these forms are striking but when all of the sampled variation within *P. longifolia* is considered, it is impossible to circumscribe clearly two species.

Perhaps the most likely explanation for this pattern is that plants of *'P. articulata'* are paedomorphic individuals of *P. longifolia*. If juvenile leaves of *P. longifolia* resemble leaves of *'P. articulata'* then only a simple change in developmental regulation could be responsible for the apparently multiple differences between these morphotypes. Similarly, Crisp & Weston (1993) found patterns of paedomorphosis in *Telopea speciosissima* to produce artifactual, 'pseudotaxonomic' patterns.

This ontogenetic hypothesis could be tested by raising *P. longifolia* from seed. The technical difficulties involved in such a project, due to the failure of *Persoonia* seeds to germinate, may not be as great as Abbott & Van Heurck's study (1988) of *P. elliptica* would suggest. *Persoonia* seeds can be induced to germinate by excising embryos from their pyrenes and sowing them under aseptic conditions on a concentrated (500 p.p.m.) solution of gibberellic acid (R. Ellyard pers. comm.; pers. obs.). Although Abbott & Van Heurck (1988) tried to break dormancy in *P. elliptica* using a GA treatment, they did not use excised embryos, but only intact pyrenes.

Discussion: *P. longifolia* is a distinctive species, readily distinguished by its combination of lamellose-flaky bark, regular flowers and compressed-reniform drupes, each containing a single, crescentic seed with two cotyledons.

Selected specimens (65 examined): Darling: Bunbury-Busselton road 6.7 km N of Stratham, 33° 25' S, 115° 37' E, *P.H. Weston 191*, Nov 1980 (SYD, PERTH); Bickley, *W.H. Loaring s.n.*, Jan 1920 (PERTH); Dwellingup, *C.A. Gardner 1003*, Feb 1922 (PERTH); Mumballup, *K. Newbey 1737*, Jan 1965 (PERTH); Yallingup Nature Reserve, 33° 42' S, 115° 06' E, *R. Pullen 9856*, Dec 1974 (CANB);

26 km E of Nannup on Bridgetown road, *G.J. Keighery 1870*, Nov 1978 (KPBG); 1 mile [1.6 km] S of Mt Barker, *K.F. Kenneally 60*, Dec 1973 (PERTH); summit Mt Clarence, *C.A. Gardner 1268*, Feb 1922 (PERTH); lower Blackwood River, *R.H. Pulleine s.n.*, Dec 1917 (NSW); Bow River, *S.W. Jackson s.n.*, Dec 1912 (NSW 2 sheets, PERTH).

5. Persoonia elliptica *R. Br.*

(Brown 1810a: 164, 1810b: 373); Sprengel (1825: 473); Meisner (1856: 341); Bentham (1870: 391); Weston (1987: 349).

Linkia elliptica (R. Br.) Kuntze (Kuntze 1891: 579).

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: ad latera saxosa collium. (ubi v.v.)'

Lectotype (here designated): on a sheet labelled 'No. 3299 R. Brown. Observatory Hill Spec 6 Descr: Decr 19. 1801'; annotated by Brown (BM, photo NSW). The specimen on the left-hand side of the sheet is designated lectotype. Isolectotypes: BM (photo NSW), E, K (photo NSW), NSW.

Persoonia laureola Lindl. (Lindley 1840: 35); Meisner (1845: 532); Meisner (1856: 341). Type citation: none given. **Lectotype (here designated):** a specimen labelled 'Swan River. Drummond, 1839' (CGE, photo NSW). Isolectotypes?: E, K, FI.

Erect shrub or small tree, usually with single main trunk, 2–8 m high, regenerating after fires from epicormic shoots or lignotuber (Abbott & Van Heurck 1988); underground parts not known. *Bark* corky, fissured, compact, grey. *Hairs* short, appressed to antrorsely spreading, greyish. *Branchlets* angular when immature but becoming terete when mature, moderately hairy when young but soon glabrescent. *Leaves* alternate, obovate to oblanceolate or rarely spathulate to narrow-spathulate, usually symmetrical but sometimes slightly asymmetrical, usually twisted at base but laminae not always held in ± vertical plane, flat or margins sometimes slightly recurved, obtuse or mucronate or acute or acuminate, not pungent, (1.5–)5–11 cm long, 9–50 mm wide, sometimes crowded at end of season's growth, mostly patent to suberect, not usually curved in dorsiventral plane, soft and flexible, not glaucous, concolorous, glabrous; venation brochidodromous; midvein prominent on adaxial surface, evident on abaxial surface; marginal veins absent: other veins evident on adaxial surface, less so or obscure on abaxial surface; epidermis smooth. *Scale leaves* triangular to narrow-triangular, acute, 1–3.5 mm long, 0.9–1.5 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic or pantotonic, (1–)4–25-flowered; rachis (0–)1–12 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 2.5–7 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to ± oblanceolate, truncate at base, slightly constricted below anthers, acute to obtuse or acuminate to mucronate, 8–12.5 mm long, 1.4–1.8 mm wide, pale greenish yellow, glabrous to sparsely hairy on outside, glabrous on inside except for marginal rows of papillae on proximal 1/2; lateral flaps absent. *Filaments* adnate to tepals or free at tips, 3–5 mm long, 1/3–2/5 as long as tepals. *Anthers* pale greenish yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free or basally adnate to tepals to lower 1/3 of loculi; connective narrower than loculi; loculi glabrous, 4–6.5 mm long; appendage absent or slightly extended beyond loculi. *Gynoecium* about as long as stamens, exserted, 8–11 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style straight or slightly sinuate, not ridged, capitate but otherwise ± constant in thickness from base to tip: abscission zone 1/4–1/2 way up stipe; ovules 2. *Hypogynous glands* 4, equal. *Drupe*

ellipsoid, smooth; long axis slightly oblique to stipe, slightly oblique to style; pyrene ellipsoid though sometimes slightly compressed, 8.5–13.5 mm long, 5–6.5 mm wide, smooth; seed 1; embryo straight; cotyledons 2.

Habitat: In grey or yellow sand to sandy loam or laterite, frequently as an understorey shrub or tree in woodland or forest dominated by *Eucalyptus marginata* and/or *E. calophylla* or less frequently in *Agonis flexuosa* woodland, often associated with *P. longifolia*; often locally common. A detailed demographic study of *P. elliptica* has been published by Abbott & Van Heurck (1988).

Flowering period: October to February.

Distribution: (Fig. 15b) South-western Australia: Perth to Albany, within 50 km of the coast.

Conservation status: Not rare.

Variation: There seems to be about as much variation within individuals as between them in *P. elliptica*.

Discussion: *P. elliptica* is clearly distinguished from all other species by the combination of large obovate to oblanceolate leaves, its habit as a single-trunked tree, its thick, corky, compact grey bark and the embryo with two cotyledons.

Selected specimens (38 examined): Darling: Bushmead, *F. Lullfitz 1820*, Dec 1962 (KPBG, PERTH); Carbunup River crossing on Busselton-Margaret River road, 33° 43' S, 115° 10' E, *B. Barnsley 818*, Jan 1979 (CBG); Great Eastern Highway 5.1 km W of Great Southern Highway, 31° 53' S, 116° 17' E, *P.H. Weston 328*, Dec 1980 (SYD, PERTH); Smith Mill, Darling Range, *A. Morrison s.n.*, Dec 1900 (AD, CANB, NSW, PERTH); 43.5 mile peg on Brookton road, *H. Demarz 1027*, Jan 1969 (CANB, PERTH); Collie, *F.W. Wakefield s.n.*, Jun 1969 (PERTH). Bunker Bay, *N. Kniep 63*, Apr 1941 (PERTH); Albany, *D.A. Herbert & E.H. Wilson 334*, Nov 1920 (PERTH); Wheatley Mill, *C.E. Lane-Poole s.n.*, Jan 1918 (PERTH).

6. Persoonia coriacea *Audas & P. Morris*

(Audas & Morris 1929: 81).

Type citation: 'Merredin, on sand plain which had apparently been burned off several years previously, destroying all the old shrubs. Max Koch, No. 3004, 30th November, 1923.'

Lectotype (here designated): on a sheet with the hand-written label: '3004. Persoonia shrub about 3 ft high as seen on a sandplain which had been burned off apparently several years ago, destroying all the old shrubs Loc: Merredin, W.A Coll: M. Koch 30.XI.1923' (MEL 103666, photo NSW). The specimen on the left-hand side of the sheet is designated lectotype. Isolectotypes: NSW (2 sheets), PERTH.

Erect, spreading shrub, usually with several to many stems branching from base or from underground, 0.3–2.0 m high, regenerating after disturbance from lignotuber; underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* short or medium length, appressed to antrorsely spreading, greyish. *Branchlets* often angular or flattened when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, spathulate to narrow-spathulate or obovate to linear-obovate or elliptical to linear-elliptical, usually slightly to prominently asymmetrical but sometimes symmetrical, twisted at base so that most of laminae are held in ± vertical plane or whole leaf twisted through 1/4–1 complete turn, flat, acute or acuminate or obtuse or mucronate, not pungent, (1–)2–6.5 cm long, 3–13 mm wide, often crowded at end of season's growth, mostly patent to suberect, sometimes curved upwards slightly, leathery and ± rigid, usually glaucous, concolorous or margins paler in colour than rest of lamina, sparsely hairy

when immature, glabrescent when mature; venation brochidodromous to parallelodromous; mid-vein evident or obscure on both surfaces; marginal veins prominent; other veins obscure or evident on both surfaces; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular, acute to obtuse, 1–3 mm long, 0.5–1.5 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic, 1–10-flowered; rachis to 7 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 2.5–9 mm long, not consistently longer at base of inflorescence than at tip, glabrous to moderately hairy. *Tepals* ± narrow-oblong, slightly constricted below anthers, acute or obtuse or acuminate or mucronate, 6.5–11.5 mm long, 1.2–1.9 mm wide, bright yellow, glabrous to moderately hairy on outside, glabrous on inside except for marginal rows of papillae on proximal 1/2; lateral flaps absent. *Filaments* adnate to tepals or free at tips, 2.2–3.8 mm long, 1/4–1/3 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free or adnate to tepals to lower 1/6 of loculi; connective narrower than to almost as wide as loculi; loculi glabrous, 3.4–6.5 mm long; appendage absent or slightly extended beyond loculi. *Gynoecium* about as long as stamens, exserted, 5.5–9.5 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight or slightly sinuate, not ridged, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal or very rarely about 1/5 way up stipe; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to ovoid though sometimes slightly compressed, smooth; long axis in line with or slightly oblique to stipe, in line with or slightly oblique to style; pyrene ellipsoid to ovoid and often compressed, 7–13 mm long, 5–7 mm wide, smooth; seed 1; embryo straight: cotyledons 3–4.

Habitat: In yellow sand or sandy loam, often over laterite, in heath or mallee-heath communities; common throughout its range.

Flowering period: November to February.

Distribution: (Fig. 16a) South-western Australia: an area roughly bounded by Carnamah, Lake Grace, Lake King and Plumridge Lakes.

Conservation status: Not rare.

Variation: Leaf morphology varies to some extent within and between populations. The northernmost (Bunjil area) and south-eastern (Lake Johnston area) populations are the only ones with mostly linear leaves. Some populations (e.g. Yellowdine) have helically twisted, non-linear leaves. This variation is more or less erratic across the species distribution.

Discussion: *P. coriacea* may be distinguished from all other species except *P. helix* by the following combination of characters: leaves (1–)2–6.5 cm long, 3–13 mm wide, leathery and ± rigid, flat, glaucous, possessing marginal veins; flowers regular; anther appendages absent. It closely resembles *P. helix* but may be distinguished from that species by the following combination of characters: leaves not twisted or twisted up to 1 turn (360°) but if so, then the leaves mostly wider than 4 mm. I have seen populations of *P. coriacea* and *P. helix* growing together (*P.H. Weston 348, 349*, SYD) with only two putative hybrid individuals present (*P.H. Weston 350, 351*, SYD), thus supporting the hypothesis of their distinct identities. The eastern part of the known distribution is remote and poorly sampled and is likely to be extended with further collecting.

Selected specimens (57 examined): Irwin: c. 13 km N of Watheroo, *C. Chapman* s.n., Jul 1978 (PERTH). Avon: 3.4 miles [5.5 km] S of Maya, *H. Demarz 1426*, Aug 1969 (KPBG, PERTH); c. 2

miles [3 km] S of Kondut, *A.S. George 504*, Jan 1960 (PERTH); Bruce Rock, *E.T. Bailey s.n.*, 1926 (PERTH). Austin: Raeside Soak, *P.H. Barrett 4*, Nov 1952 (PERTH). Coolgardie: 12 km SW of Callion, *K. Newbey 8768*, Aug 1981 (PERTH); N of Bullabulling, *J.S. Beard 3338*, May 1964 (KPBG, CANB); 54 miles [87 km] W of Coolgardie towards Southern Cross, *M.E. Phillips s.n.*, Sep 1968 (AD, CBG, NSW); 3.9 km W of Yellowdine, 31° 18' S, 119° 36' E, *P.H. Weston 143*, Nov 1980 (SYD). Roe: Wave Rock Hyden, *J.W. Wrigley s.n.*, Nov 1968 (CBG, NSW); 30 miles [49 km] E of Lake Grace, *A.S. George 2273*, Dec 1960 (PERTH). Helms: c. 35 km W of Plumridge Lakes, 29° 34' S, 124° 52' E, *M.D. Crisp 5843*, *J. Taylor & R. Jackson*, Sep 1979 (CBG).

7. Persoonia helix *P.H. Weston*, **sp. nov.**

Folia (0.6–)2–6 cm longa, 1.5–4 mm lata, tortilis. Flores regulares. Tepala glabra vel pilis sparsis griseis obtecta. Appendix antherae usque ad 0.2 mm longa vel deficiens. Gynoecium exsertum, glabrum, stamina aequans.

Holotype: Western Australia: Roe: 29 miles [47 km] east of Forrestania, *F. Lullfitz L3875*, 25 Nov 1964 (PERTH). Isotype: KPBG.

Erect, spreading shrub, usually with several to many stems branching from base or from underground, 0.4–2.8 m high, regenerating after disturbance from lignotuber; underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* short to medium length, appressed to antrorsely spreading, greyish. *Branchlets* often angular when very immature but soon becoming terete, moderately to densely hairy when young but glabrescent after 2 or 3 years. *Leaves* alternate, usually linear or occasionally narrow-oblong, twisted through 1/2–6 complete turns, flat, acute to acuminate, not pungent, (0.6–)2–6 cm long, 1.5–4 mm wide, often crowded at end of season's growth, mostly suberect to erect, occasionally curved upwards slightly, leathery and rigid or slightly flexible, usually glaucous, concolorous or margins paler in colour than rest of lamina, glabrous to sparsely hairy when immature, glabrescent when mature; venation parallelodromous; midvein evident or obscure on both surfaces; marginal veins prominent; few other veins evident on both surfaces or obscure;

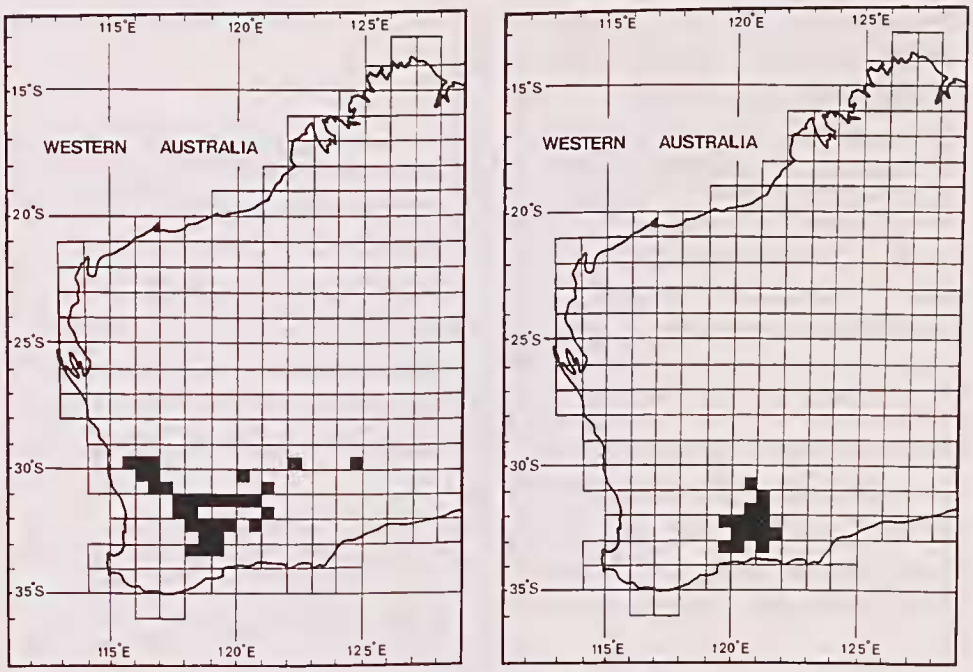

Figure 16. Distributions of **a**, *Persoonia coriacea* and **b**, *Persoonia helix*.

epidermis smooth except margins which are papillose and scaberulous or sometimes rest of lamina papillose but not as densely so as margins. *Scale leaves* triangular, acute to acuminate, 0.8–2 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic, 1–5-flowered; rachis to 2.5 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 3–6 mm long, not consistently longer at base of inflorescence than at tip, glabrous to moderately hairy. *Tepals* ± narrow-oblong, slightly constricted below anthers, acuminate to mucronate, 8–11 mm long, 1.4–1.8 mm wide, bright yellow, glabrous to sparsely hairy on outside, glabrous on inside except for 2 marginal rows of papillae below anthers; lateral flaps absent. *Filaments* adnate to tepals, 2.3–3 mm long, 1/4–3/10 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free or adnate to tepals to lower 1/10 of loculi; connective narrower to almost as wide as loculi; loculi glabrous, 4.4–5.6 mm long; appendage absent or slightly extended beyond loculi. *Gynoecium* about as long as stamens, exserted, 7–9.5 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight, not ridged, capitate but otherwise constant in thickness from base to tip; abscission zone basal or very rarely about 1/3 way up stipe; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to ovoid and often compressed, smooth; long axis slightly oblique to stipe, in line with style; pyrene ellipsoid to ovoid and compressed, 7–9.5 mm long, 4.5–7 mm wide, smooth; seed 1 or rarely 2; embryo straight: cotyledons 3–4.

Derivation of epithet: From the Greek *helix*, a spiral, in reference to the twisted leaves.

Habitat: In yellow or white sand or sandy loam, often over laterite, in heath mallee-heath or mallee-woodland: common throughout its range.

Flowering period: November to February.

Distribution: (Fig. 16b) Roe, Coolgardie and Eyre districts: an area roughly; bounded by Kalgoorlie, Hyden, Ravensthorpe and Salmon Gums.

Conservation status: Not rare.

Variation: The degree of leaf twisting and to a much less extent leaf and flower dimensions vary between specimens. However, these do not seem to be geographically or ecologically correlated. It is possible that some specimens with wider, relatively less twisted leaves could be *P. helix* x *P. coriacea* hybrids.

Discussion: This species is readily distinguished from all other species except *P. coriacea* by the following combination of characters: (a) leaves, flat, linear, twisted through 1/2–6 complete turns (b) marginal veins present (c) other veins evident to obscure (d) anther appendage absent or only slightly extended beyond the loculi (e) gynoecium glabrous. It is distinguished from *P. coriacea* as noted in the discussion of that species. It has been misidentified persistently as *P. tortifolia* (a synonym of *P. trinervis*) because of its twisted leaves. However, it may be distinguished readily from *P. trinervis* by characters (c), (d) and (e) above.

Selected specimens (35 examined): Coolgardie: 18 km NW of Bullabulling, *K. Newbey 8753*, Aug 1981 (PERTH); Hollands Track 33 miles [53 km] SW of Queen Victoria Rock, *R. Filson 8900*, Sep 1966 (PERTH); Johnston Lakes, *R. Aitkin s.n.*, Dec 1977 (PERTH). Roe: E of Mt Holland, *C.A. Gardner s.n.*, Jun 1929 (PERTH); junction of Salmon Gums-Lake King road with Peak Charles road, 32° 45' S, 121° 17' E, *P.H. Weston 245*, Dec 1980 (SYD, NSW, PERTH); Peak Eleanora, *K. Newbey 6350*, Nov 1979 (PERTH); Frank Hann National Park, *R.D. Royce 10207*, Dec 1971 (PERTH); Salmon Gums, *C.W.L. Holt s.n.*, Jan 1960 (PERTH). Eyre: Mt Short, *J.W. Wrigley s.n.*, Nov 1968 (CBG, PERTH).

8. Persoonia pertinax *P.H. Weston*, **sp. nov.**

Folia (0.7–)2–5.5 cm longa, 1–2.5 mm lata, dorsiventraliter complanata, asymmetricissima, ad basim torta per quartum gyri. Flores regulares. Gynoecium glabrum, exsertum, stamina aequans. Appendix antherae obsoleta vel usque ad 0.1 mm longa.

Holotype: Western Australia: Helms: Queen Victoria Spring, *R.D. Royce 5299*, 27 Jan 1956 (PERTH).

Erect, spreading shrub 1–2.5 m high; branching pattern, means of regeneration, underground parts not known. *Bark* smooth, compact, grey. *Hairs* of medium length, appressed, greyish. *Branchlets* terete, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, slightly to prominently asymmetrical, usually twisted at base so that most of laminae are held in ± vertical plane, dorsiventrally flattened, acute to acuminate, not pungent, (0.7–)2–5.5 cm long, 1–2.5 mm wide, sometimes crowded at end of season's growth, mostly patent to suberect, curved upwards slightly to prominently, leathery and flexible, not glaucous, concolorous, moderately hairy when immature, glabrescent when mature; venation hyphodromous to parallelodromous; midvein evident on both surfaces; marginal veins obscure to evident; intramarginal veins obscure to evident on both surfaces; other veins obscure; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to obtuse, 0.7–2.5 mm long, 0.5–0.7 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or rarely anauxotelic, basitonic, 1–10-flowered; rachis to 6 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 3.5–7 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong, constricted below anthers, acute to acuminate, 8–11 mm long, 1–1.5 mm wide, yellow, moderately to densely hairy on outside, glabrous on inside except for marginal rows of papillae below anthers; lateral flaps absent. *Filaments* adnate to tepals, 2–3 mm long, 3/10–1/5 as long as tepals. *Anthers* yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free: connective narrower than loculi; loculi glabrous, 3–6 mm long; appendage absent or slightly extended beyond loculi. *Gynoecium* about as long as stamens, exserted,. 7–10 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight, not ridged, capitate but otherwise slightly tapered from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to ovoid and compressed, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene ellipsoid to ovoid and compressed, 8.5–11 mm long, 4.5–6 mm wide, smooth; seed 1; embryo straight; cotyledons 4.

Derivation of epithet: From the Latin, *pertinax*, tenacious or unyielding, referring to the ability of this species to withstand its arid habitat.

Habitat: In red sand, in open woodland; locally common.

Flowering period: January to March.

Distribution: (Fig. 17a) Helms and Coolgardie districts: within 50 km of Cundeelee.

Conservation status: Not rare.

Variation: *P. pertinax* is not well sampled and only two collections are of flowering material. Between-individual variation appears to be no greater than that within individuals.

Discussion: This species is distinguished from all others by a combination of the following characters: leaves linear, dorsiventrally flattened, prominently asymmetrical,

(0.7–)2–5 cm long, 1–1.6 mm wide, with marginal veins; flowers regular; anther appendages absent. It most closely resembles *P. coriacea* and *P. helix* but has narrower leaves than these species. It has been misidentified as *P. striata* but differs from that species in its hairy perianth, in anther characters, in inflorescence characters and in its non-striate leaves.

Selected specimens (10 examined): Coolgardie: 18 km N of Cundeelee, 30° 33' S, 123° 25' E, *P.M. Olde 88/16*, Sep 1988 (NSW, PERTH); Cundeelee, *P. Boswell C28*, 1967 (PERTH); 20 miles [32 km] E of Cundeelee, *M.C. George s.n.*, Mar 1963 (NSW, NT); Ponton Creek, 31° 02' S, 123° 47' E, *J. Taylor 549, M.D. Crisp & R. Jackson*, Sep 1979 (CBG, PERTH); Helms: near Queen Victoria Spring, *A.S. George 5873*, Sep 1963 (PERTH); near Streich Mound, *A.R. Main s.n.*, Aug 1960 (PERTH).

9. Persoonia cymbifolia *P.H. Weston*, sp. nov.

Folia (0.4–)1.5–4.5 cm longa, 1–3 mm lata, plana vel valde concava, papillosa, scabra. Inflorescentiae auxotelicae. Flores regulares. Antherae flavae, sine appendice. Ovarium pubescens. Stipes glaber. Stylus basaliter pubescens, distaliter glaber. Ovula 2.

Holotype: Western Australia: Roe: 14.5 km N of Mt Ridley, 33° 09' 30" S, 122° 08' 00" E, *W.R. Archer 712912*, 7 Dec 1991 (PERTH). Isotypes: K, NSW.

Erect, spreading shrub ca. 0.2–0.6 m high, with several to many stems branching from base; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish to mid-brown. *Branchlets* terete, densely hairy when young but glabrescent with age. *Leaves* alternate, narrow-oblong to linear, straight to prominently asymmetrical, twisted through 0–1/2 complete turn, flat to strongly concave, acute to acuminate, sharp but not pungent, (0.4–)1.5–4.5 cm long, 1–3 mm wide, crowded, erect, straight or curved upwards slightly to prominently, leathery and flexible to rigid, not glaucous, concolorous, sparsely to moderately hairy when less than 2 years old,

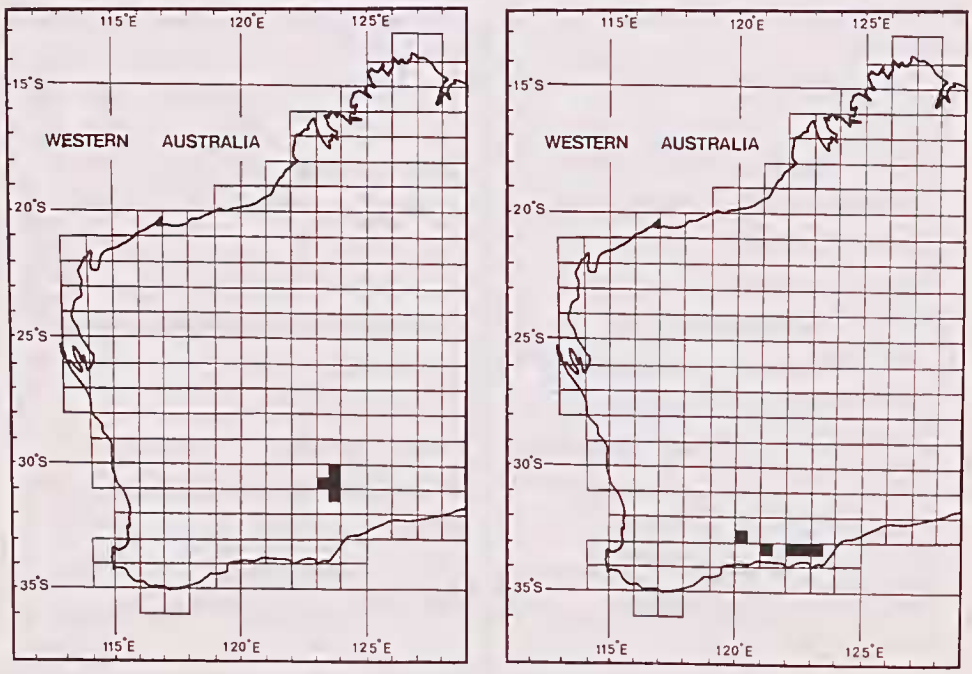

Figure 17. Distributions of **a**, *Persoonia pertinax* and **b**, *Persoonia cymbifolia*.

glabrescent with age; venation hyphodromous to parallelodromous; veins obscure to evident on both surfaces; epidermis papillose and scabrous. *Scale leaves* triangular to oblong, obtuse to acute, 0.5–2 mm long, 0.5–0.8 mm wide. *Inflorescences* axillary or terminal, auxotelic, basitonic, 1–3-flowered; rachis to 0.1 cm long. *Flowers* subtended by scale leaves, regular, held upright to subupright. *Pedicels* 2–3.5 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong, slightly constricted below anthers, acuminate, 7–11.5 mm long, 1–1.5 mm wide, yellow, moderately hairy on outside, glabrous on inside except for marginal rows of papillae below anthers; lateral flaps absent. Filaments adnate to tepals, 2–3.5 mm long, 1/4–1/3 as long as tepals. *Anthers* yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; connective narrower than loculi; loculi glabrous, 4–6 mm long; appendage absent. *Gynoecium* about as long as stamens, exserted, 6–10 mm long; ovary moderately hairy, basally contracted into distinct, glabrous stipe, slightly thicker than base of style; style moderately hairy at base but becoming glabrous towards tip, straight, not ridged, capitate but otherwise tapering from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to ovoid, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene compressed-ellipsoid to compressed-ovoid, 8.5–10 mm long, 5–5.5 mm wide, smooth; seed 1; embryo straight; cotyledons 3.

Derivation of epithet: Latin *cymba*, a boat, and *folium*, leaf, referring to the concave, cymbiform leaves.

Habitat: In sandy soils or in rock crevices, in heath; locally rare to common.

Flowering period: December to January.

Distribution: (Fig. 17b) Roe district: an apparently narrow band stretching from Frank Hann National Park through the Mt Ridley – Dingo Rock area, to Mt Buraminya and the Russell Range.

Conservation status: Not rare (coded 2VCi as *Persoonia* sp.4 and 2KC– as *Persoonia* sp.12 by Briggs & Leigh (1989), on the basis of a previous erroneous circumscription of the species).

Variation: Leaf concavity varies geographically. Specimens from Frank Hann National Park to the Mt Ridley area have strongly concave leaves while the leaves of the specimen from the Russell Range are either flat or slightly concave. Geographically intermediate specimens (e.g. Mt Buraminya) have shallowly concave leaves.

Discussion: *P. cymbifolia* is a distinctive species that does not closely resemble any other. Superficially, it is most similar to *P. pertinax*, but differs most obviously from that species in its hairy gynoecium. It is distinguished by the following combination of characters: leaves flat to strongly concave, papillose-scabrous; anther appendages absent; ovary and style base hairy, stipe glabrous.

Selected specimens (18 examined): Roe: 33.2 km SW of 90 mile tank on Hanns Track, 32° 52' S, 120° 25' E, *P.H. Weston 249*, Dec 1980 (SYD); 26 km NW of Roberts Swamp, 33° 03' S, 121° 10' E, *K. Newbey 8182*, Nov 1980 (PERTH); 11 km N of Mt Ridley, 33° 11' 30" S, 122°08'00" E, *W.R. Archer 712911*, Dec 1991 (NSW); 35.5 km NE of Mt Heywood, 33° 09' 30" S, 122° 51' 00" E, *W.R. Archer 2612917*, Dec 1991 (NSW, K, PERTH, CANB); 2 km SW of Mt Buraminya, 33° 14' S, 123° 06' E, *W.R. Archer 3108915*, Aug 1991 (NSW); 2.5 km S of Tower Peak, 33° 28' S, 123° 28' E, *M.D. Crisp 4823*, Jan 1979 (CBG).

10. Persoonia leucopogon *S. Moore*

(Moore 1899: 220)

Type citation: 'Repperi inter Uladdie et Yilgangie, ubi florescit mens. Mart.'

Lectotype (here designated): on a sheet labelled 'West Australian Goldfields. Spencer Moore 1895. Persoonia Leucopogon (sp. nov.) S. Moore. Small subshrub about 2 feet or so. Flowers yellow. Between Uladdie and Yilgangie. March '95'; annotated by Moore (BM, photo NSW). The specimen on the right-hand side is designated lectotype.

Isolectotype: NY.

Erect or decumbent shrub 0.3–0.6 m high; means of regeneration, underground parts not known. *Bark* not known. *Hairs* short to medium length, appressed to antrorsely spreading, grey to ferruginous. *Branchlets* densely hairy when young but becoming moderately hairy when mature and eventually glabrescent with age. *Leaves* alternate, narrow-elliptical to narrow-oblong, symmetrical to slightly asymmetrical, twisted to 1 complete turn, flat, acuminate, sharp but not pungent, 0.7–1.5 cm long, 1.3–2.2 mm wide, crowded, patent to erect, not curved in dorsiventral plane, leathery and rigid, somewhat glaucous, concolorous; venation hyphodromous; midvein evident on both surfaces; marginal veins evident; other veins obscure on both surfaces or evident on abaxial surface. *Scale leaves* ovate, acute, 1–3 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic, basitonic, 1–4-flowered; rachis to 0.2 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, spreading to upright. *Pedicels* 2.5–4 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong, slightly constricted below anthers, acute, 8.5–10.5 cm long, 1–1.3 mm wide, yellow, densely hairy on outside, glabrous on inside except for marginal rows of papillae below anthers; lateral flaps absent. *Filaments* adnate to tepals, 2–2.5 mm long, ca. 1/4 as long as tepals. *Anthers* yellow, sublatrorse, free; connective narrower than loculi; loculi glabrous; appendage absent. *Gynoecium* about as long as stamens, exserted, 8–9 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style straight, not ridged, ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* subglobular, smooth; long axis in line with or slightly oblique to stipe, slightly oblique to style; pyrene broad-ovoid and slightly compressed, 6–7 mm long, 5–5.5 mm wide, smooth; seed 1; embryo straight; cotyledons 3–4.

Habitat: In yellow sand or loam, in heath; found as occasional or isolated individuals.

Flowering period: November to March.

Distribution: (Fig. 18a) Coolgardie district: Bungalbin and an unknown locality between Coolgardie and Laverton.

Conservation status: 3K- (proposed here, to replace 1X coding of Briggs & Leigh 1988).

Variation: Only three collections have been made of this species and no significant variation is evident.

Discussion: This species resembles *P. pungens* most closely but may be distinguished from it by its densely hairy pedicels and tepals. It is distinguished from all other species by the following combination of characters: leaves twisted, narrow-elliptical to narrow-oblong, sharp but not pungent, 0.8–1.5 cm long, 1.5–2 mm wide; flowers regular; anther appendages minute. *P. leucopogon* was probably first collected from one of the isolated patches of yellow sand north of Kalgoorlie. These patches support

rich assemblages of heathland species in contrast to the surrounding red soils which support relatively depauperate eucalypt or *Acacia* woodlands or *Atriplex* shrublands.

Specimens examined: Western Australia: Coolgardie: 3 km N of N end of Helena and Aurora Range (Bungalbin), *G.J. Keighery 4422*, Dec 1981 (PERTH); 16.5 km NE of Bungalbin Hill, 30°17' S, 119°46' E, *R.J. Cranfield 8140*, Oct 1991 (PERTH).

11. Persoonia pungens *W. Fitzg.*

(Fitzgerald 1912: 23).

Type citation: 'Kellerberrin; F. H. Vachel. Prope Kellerberrin; leg. W.V.F.'

Lectotype (here designated): on a sheet labelled 'Kellerberrin Nov 1907 spreading rigidly branched 18 in high coll. W V F.'; annotated by Fitzgerald (NSW 154139). Isolectotypes: BM, NSW (2 sheets), PERTH. Residual syntypes: Kellerberrin, *Vachell*, Dec 1903 (NSW, 2 sheets).

Erect to decumbent or almost prostrate shrub with abundant lateral short shoots, branching from base, 0.2–0.8 m high, regenerating after disturbance from lignotuber, without spreading or extensive underground stems but with thickened taproot. *Bark* smooth, compact, mottled grey or brown. *Hairs* of medium length, antrorsely spreading to patent, greyish. *Branchlets* terete, densely hairy when young but glabrescent with age. *Leaves* alternate, elliptical to narrow-elliptical or narrow-oblong, symmetrical to slightly asymmetrical, twisted to 1 complete turn, flat, acuminate to mucronate, pungent, (0.3–)0.5–1.5 cm long, 1–5 mm wide, often crowded, mostly patent to suberect, not curved in dorsiventral plane, leathery and rigid, not glaucous, concolorous, sparsely hairy when immature, glabrescent when mature; venation hyphodromous or brochidodromous; midvein obscure to evident on both surfaces; marginal veins absent; other veins obscure to evident on both surfaces; epidermis

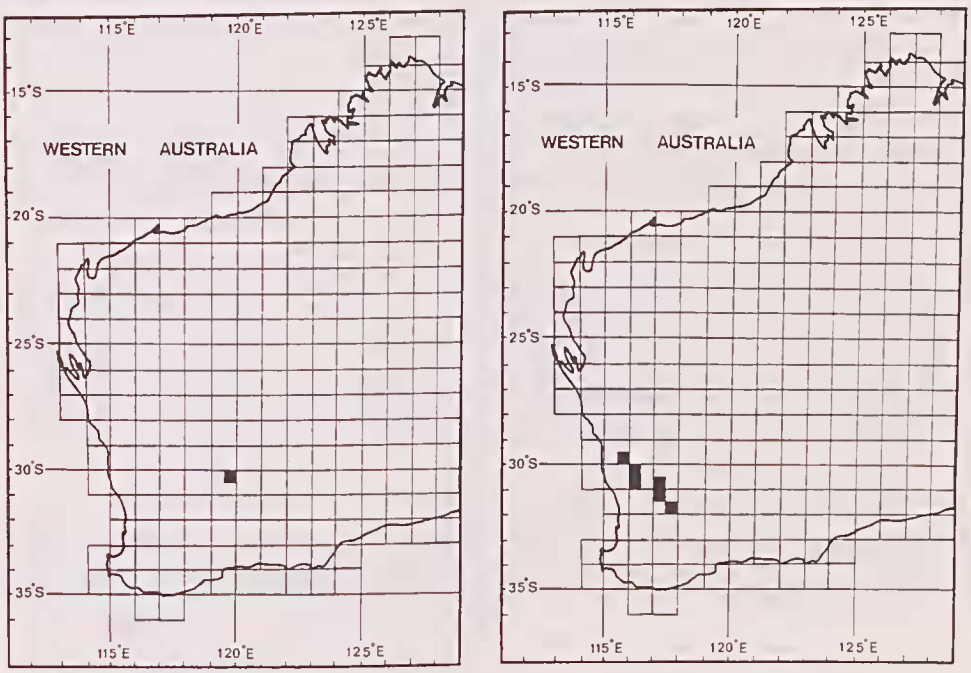

Figure 18. Distributions of **a**, *Persoonia leucopogon* and **b**, *Persoonia pungens*.

papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 0.7–1.8 mm long, 0.3–0.5 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or anauxotelic, basitonic, 1–5-flowered; rachis to 0.5 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 1–3 mm long, not consistently longer at base of inflorescence than at tip, glabrous to sparsely hairy. *Tepals* ± narrow-oblong, constricted below anthers, acute or acuminate or obtuse or mucronate, 9–12.5 mm long, 1.4–2 mm wide, bright yellow, glabrous on outside, glabrous on inside except for marginal rows of papillae on proximal 1/2; lateral flaps absent. *Filaments* adnate to tepals or free at tips, 3–4 mm long, 1/4–2/5 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; connective narrower than loculi; loculi glabrous, 4–6.5 mm long; appendage absent. *Gynoecium* about as long as stamens, exserted, 7.5–10 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight, not ridged, capitate but otherwise ± constant in thickness or slightly tapered from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* lenticular or ellipsoid to ovoid and compressed, smooth; long axis in line with or slightly oblique to stipe, slightly oblique to style; pyrene ellipsoid to ovoid and compressed, 6–8 mm long, 5–6.5 mm wide, smooth; seed 1; embryo straight; cotyledons 4–6.

Habitat: In white or yellow sand to loam, in heath; sometimes locally common.

Flowering period: September to December.

Distribution: (Fig. 18b) Irwin and Avon districts: from the Coorow area south-east to Kellerberrin.

Conservation status: 3V (Briggs & Leigh 1988).

Variation: There is some variation between specimens with respect to leaf shape and dimensions but this does not appear to be geographically correlated. One specimen (*A. Strid 21723*, NSW) has larger leaves ((1.0–)1.4–2.4 cm long, 2–4 mm wide), and longer pedicels (3–5.5 mm long) than other specimens and has few lateral short shoots. This specimen may be a hybrid of *P. pungens*, perhaps with *P. coriacea*.

Discussion: This species is readily distinguished from all other species by the following combination of characters: anthers lacking appendages; tepals glabrous on the outside; leaves elliptical to narrow-elliptical or narrow-oblong, (0.3–)0.5–1.5 cm long, 1–5 mm wide, pungent. It most closely resembles *P. leucopogon* but differs from that species in its less densely hairy pedicels and perianth.

Selected specimens (14 examined): Irwin: Winchester, *C. Chapman s.n.*, Sep 1969 (PERTH); c. 15 km W of Coorow 29° 55' S, 115° 50' E, *P.H. Weston 162*, Nov 1980 (SYD, NSW, PERTH); 18 km N of Watheroo on Midland road, *C. Chapman s.n.*, Dec 1980 (SYD, NSW, PERTH). Avon: Namelcatchem, 3 miles [5 km] S of Minnivale 31° 11' S, 117° 11' E, *B.H. Smith 196*, Nov 1982 (MEL, NSW, PERTH); Hindmarsh Rifle Range, 31° 19' S, 117° 08' E, *B.H. Smith 1029*, Nov 1987 (NSW); Lake Derdibin, 31° 18' S, 117° 20' E, *B.H. Smith 1033*, Nov 1987 (NSW); Dingo Rock, 30° 52' S, 117° 01' E, *B.H. Smith 1134*, Nov 1988 (NSW).

12. Persoonia baeckeoides *P.H. Weston*, **sp. nov.**

Folia spathulata vel anguste spathulata, 0.5–1.1 cm longa, 2–4 mm lata. Flores regulares. Gynoecium glabrum, exsertum, stamina aequans. Tepala glabra. Appendix antherae deficiens.

Holotype: Western Australia: Roe: 200 metres west of turn-off to Peak Charles on Hann's Track, 32° 45' S, 121° 18' E, *P.H. Weston 246*, 5 Dec 1980 (SYD). Isotypes: CANB, K, PERTH.

Erect, spreading shrub, with many stems branching from base, 0.5–0.9 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* short to medium length, appressed to antrorsely spreading, greyish to pale brown. *Branchlets* angular when immature and remaining so when mature but becoming terete within 2 years, moderately hairy when young but glabrescent with age. *Leaves* alternate, spathulate to narrow-spathulate, symmetrical, twisted at base but lamina not always held in ± vertical plane, flat, obtuse, not pungent, (0.3–)0.5–1.1 cm long, 2–4 mm wide, crowded, mostly suberect, not curved in dorsiventral plane, leathery and rigid, often slightly glaucous, concolorous, glabrous; venation hyphodromous; marginal veins absent; epidermis smooth. *Scale leaves* triangular, acute, 1–1.5 mm long, 0.4–0.7 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic, basitonic, 1–3-flowered; rachis to 0.2 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 2–3 mm long, not consistently longer at base of inflorescence than at tip, glabrous to sparsely hairy. *Tepals* ± narrow-oblong, slightly constricted below anthers, acute to obtuse, 7.5–9 mm long, about 1.5 mm wide, greenish-yellow, glabrous; lateral flaps absent. *Filaments* adnate to tepals, 2–2.5 mm long, about 1/4 as long as tepals. *Anthers* greenish-yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; connective narrower than loculi; loculi glabrous, 4–6 mm long; appendage absent. *Gynoecium* about as long as stamens, exserted, 7–8 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style glabrous, straight, not ridged, capitate but otherwise constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to ovoid though sometimes slightly compressed, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene ellipsoid though sometimes slightly compressed, 8–10.5 mm long, 5–5.5 mm wide, smooth; seed 1; embryo straight; cotyledons 3–4.

Derivation of epithet: In reference to *Baeckea*, a genus of small-leaved Myrtaceous shrubs, several species of which superficially resemble this new species in leaf morphology.

Habitat: In yellow sandy loam over laterite, in heath; in small populations.

Flowering period: November to December.

Distribution: (Fig. 19a) Roe district: Two localities 20 km NW and 20 km NE of Peak Charles.

Conservation status: 2K (Briggs & Leigh 1988, as *Persoonia* sp.11).

Variation: Only four collections from two populations have been made of this species and within this sample, between-individual variation seems no greater than that within individuals.

Discussion: This species is a distinctive one, not closely resembling any others. It is distinguished by the following characters: leaves mostly spathulate, (0.3–)0.5–1.1 cm long, 2–4 mm wide; flowers regular; tepals glabrous; anther appendages absent. It was first collected only in 1966, no doubt because of its remote distribution.

Specimens examined: Roe: 1 km W of Peak Charles turnoff Norseman–Lake King road, *K. Newbey 5627*, Aug 1979 (PERTH); near Peak Charles turnoff Lake King–Norseman road 32°45' S, 212°18' E, *K. Newbey 7217*, Aug 1980 (PERTH); 50 km W of Kumarl, *P.G. Wilson 5679*, Oct 1966 (PERTH).

13. Persoonia cordifolia *P.H. Weston*, **sp. nov.**

Folia opposita, decussata, late cordata, 0.7–1.2 cm longa, 6–13 mm lata. Inflorescentiae auxotelicae. Flores regulares. Antherae flavae; appendix antherae oblonga, c. 2 mm longa. Ovarium glabrum. Ovula 2.

Holotype: Western Australia: Roe: 44 km NE of Mt Heywood, 33° 03' S, 122° 50' E, *W.R. Archer 2612911*, 26 Dec 1991 (PERTH). Isotypes: CANB, K, MO, NSW.

Erect, rounded to spreading shrub, with many stems branching from base, 1–2 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* short, patent, greyish. *Branchlets* terete, moderately hairy when young but glabrescent with age. *Leaves* opposite-decussate, broad-cordate, symmetrical, not twisted, flat or slightly concave, mucronate, not pungent, 0.7–1.2 cm long, 6–13 mm wide, not crowded, mostly patent, not curved in dorsiventral plane, leathery and rigid, not glaucous, concolorous, sparsely hairy when immature, glabrescent when mature; venation hyphodromous; marginal veins obscure; epidermis papillose and scaberulous. *Scale leaves* triangular, acute, 1–1.5 mm long, 0.5–1.0 mm wide. *Inflorescences* mostly terminal, auxotelic, basitonic, (1–)2–8-flowered; rachis to 2.5 cm long. *Flowers* subtended by scale leaves basally and leaves distally, regular, upright to pendulous depending on orientation of inflorescence. *Pedicels* 3–5 mm long, not consistently longer at base of inflorescence than at tip, sparsely hairy. *Tepals* ± narrow-ovate, constricted below anthers, acute, c. 11 mm long, c. 2 mm wide, bright yellow, sparsely hairy on outside, glabrous on inside except for marginal rows of papillae on proximal 1/3; lateral flaps absent. *Filaments* adnate to tepals, c. 2 mm long, c. 1/5 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, adnate to tepals for about lower 1/8 of loculi; connective narrower than loculi; loculi glabrous, 5.5–6 mm long; appendage narrow-oblong, 1.5–2 mm long, 1/3–1/4 as long as loculi. *Gynoecium* about as long as stamens, exserted, 10.5–11 mm long,

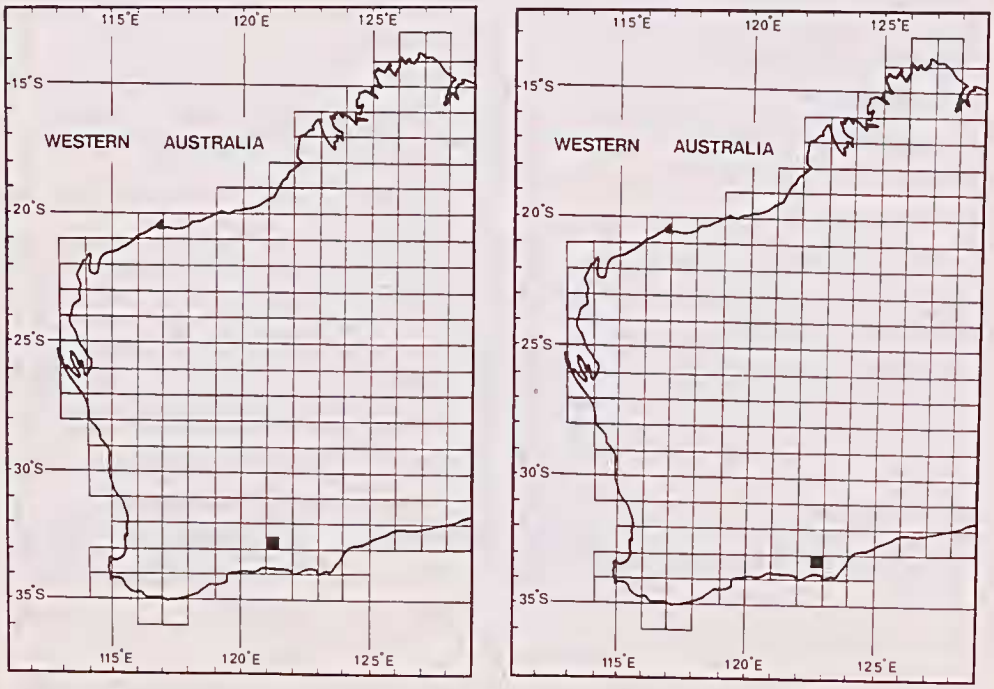

Figure 19. Distributions of **a**, *Persoonia baeckeoides* and **b**, *Persoonia cordifolia*.

glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style glabrous, straight, not ridged, capitate but otherwise constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* not known.

Derivation of epithet: Latin *cordatus*, cordate, and *folium*, leaf, in reference to the heart-shaped leaves.

Habitat: In yellow sand or sandy loam, in heath; in small populations.

Flowering period: December to January.

Distribution: (Fig. 19b) Roe district: within 8.5 km of the type locality.

Conservation status: 2K (proposed here).

Variation: Only four collections, from two geographically close populations, have been made of this species and no significant between-individual variation is evident.

Discussion: *P. cordifolia* is a distinctive species, not closely resembling any others. It is one of the few species of *Persoonia* with opposite-decussate phyllotaxis and this feature, together with its broad-cordate leaves, is sufficient to distinguish it from all other species. It was first collected only in 1990, by W.R. Archer, who commented that he was reasonably familiar with the areas west, east and south of the two known populations but that he had not seen it anywhere else.

Specimens examined: Roe: 44 km NE of Mt Heywood, 33°03' S, 122°50' E, *W.R. Archer 2212903–2212904*, Dec 1990 (NSW, AD, CANB, PERTH); 42 km NE of Mt Heywood, 33°00' S, 122°46' E, *W.R. Archer 2212905*, Dec 1990 (NSW, PERTH).

14. Persoonia dillwynioides *Meisn.*

[Meisner (1852: 185) nom. nud.] (Meisner 1856: 333); Bentham (1870: 388).

Linkia dillwynioides (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'In colonia Swan River (Drumm. 5, n. 403!)'

Lectotype (here designated): a specimen labelled by Meisner '*Persoonia dillwynioides* nob. (13.Apr.1851.) Swan River. legit Drummond, n. 403! D.am. Shuttleworth. 11.Oct.1853.' (NY). Isolectotypes: BM, CGE, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, NSW, PERTH.

Erect, spreading shrub, usually with several to many stems branching from base, 0.6–1.8 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish. *Branchlets* sometimes slightly angular when immature but becoming terete when mature, moderately hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, twisted through 1/4–1 complete turn, deeply concave to subterete and grooved above, acuminate, sharp but not pungent, (0.5–)1.0–2.0 cm long, 0.7–1.3 mm wide, crowded, mostly suberect to erect, not curved in dorsiventral plane, leathery and rigid to rather flexible, not glaucous, concolorous, sparsely hairy when immature, glabrescent when mature; venation hyphodromous; marginal veins obscure; epidermis slightly papillose and scaberulous. *Scale leaves* triangular, acuminate to cuspidate, 0.5–1.5 mm long, 0.5–0.6 mm wide. *Inflorescences* mostly terminal or subterminal but occasionally axillary, auxotelic or very rarely anauxotelic, basitonic, 1–4-flowered; rachis to 0.3 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 1.5–2.5 mm long,

not consistently longer at base of inflorescence than at tip, glabrous. *Tepals* ± narrow-oblong, constricted below anthers, acute, 10–12 mm long, 1.3–1.5 mm wide, bright yellow, glabrous on outside, glabrous on inside except for marginal rows of papillae below anthers; lateral flaps absent. *Filaments* adnate to tepals, 2.5–3.5 mm long, 1/4–2/7 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, adnate to tepals for about lower 1/6 of loculi; connective narrower than loculi; loculi glabrous, 5–6 mm long; appendage present but sometimes vestigial, ± oblong, to 0.4 mm long, to 1/15 as long as loculi. *Gynoecium* about as long as stamens, exserted, 9.5–11.5 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style ± straight, not ridged, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to ovoid and often compressed, smooth; long axis slightly oblique to stipe; in line with style; pyrene ellipsoid to ovoid and compressed, 7–10.5 mm long, 4–5 mm wide, smooth; seed 1 or rarely 2; embryo straight; cotyledons 3.

Habitat: In gravelly sand or loam to clay, in low heath; in small populations.

Flowering period: November to December.

Distribution: (Fig. 20a) Eyre district: between the Gairdner River and Hopetoun, within 50 km of coast.

Conservation status: 2RCi (Briggs & Leigh 1988).

Variation: This species is little collected and within-individual variation seems to be as great as that between individuals.

Discussion: *P. dillwynioides* is a distinctive species, readily distinguished from all others by its twisted, linear, deeply concave leaves which are (0.5–)1–2 cm long, 0.7–1.3 mm wide.

Specimens examined: Eyre: Ravensthorpe Range 6 km NE of Ravensthorpe, *K. Newbey*

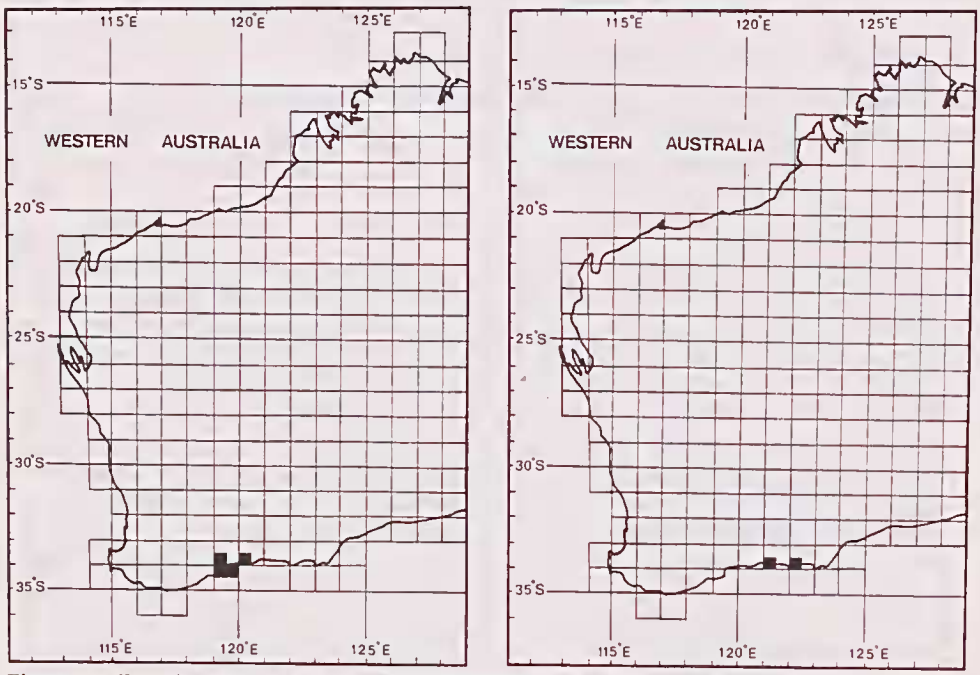

Figure 20. Distributions of **a**, *Persoonia dillwynioides* and **b**, *Persoonia flexifolia*.

8271, Mar 1981 (PERTH); 0.2 km W of Susetta River Old Ongerup Road, 33° 52' S, 119° 26' E, *P.H. Weston 239*, Dec 1980 (SYD, NSW, PERTH); 5.5 km N of Hopetoun 33° 54' S, 120° 08' E, *P.H. Weston 241*, Dec 1980 (SYD, CANB, K, MEL, NSW, PERTH); 2 miles [3 km] N of Hopetoun, *K. Newbey 2755*, (PERTH); W of lower Fitzgerald River 34° 05' S, 119° 30' E, *A.S. George 11760*, Dec 1973 (CANB, PERTH n.v.), Fitzgerald River Reserve, *R.D. Royce 8933*, Jul 1970 (PERTH).

15. Persoonia flexifolia *R. Br.*

(Brown 1810a: 162, 1810b: 372); Sprengel (1825: 473); Meisner (1856: 33); non Lodd. (Loddiges 1824: t. 922).

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: ad latera saxosa collium. (ubi v.v.)'

Lectotype (here designated): A sheet labelled 'R. Brown No. 3282 Ad latera saxosa collium sterilium ora australis Nova Hollandia ad Bay I Jan 1802 s. s obs: May 1803'; annotated by Brown (BM photo NSW). The specimen on the right-hand side of the sheet is designated lectotype.

Erect shrub; other habit characters not known. *Hairs* of medium length, appressed to antrorsely spreading, whitish to greyish. *Branchlets* often angular when immature but becoming terete when mature, moderately hairy when young but glabrescent with age. *Leaves* alternate, usually narrow-oblong or occasionally narrow-elliptical or narrow-spathulate, symmetrical or slightly asymmetrical, usually twisted through 1/4–1/2 complete turn, flat to slightly concave or convex, acuminate, sharp but not pungent, (0.4–)1.0–2.5 cm long, 1.8–3.0 mm wide, sometimes crowded, mostly erect to suberect, sometimes curved upwards slightly, leathery and flexible, not glaucous, concolorous, glabrous to sparsely hairy when immature, glabrescent when mature; venation brochidodromous; midvein usually evident or occasionally prominent or obscure on adaxial surface; marginal veins obscure to prominent; other veins obscure to evident on both surfaces; epidermis papillose and scaberulous. *Scale leaves* triangular, acute, 1–2 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic, basitonic, 1–3-flowered; rachis to 0.4 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 1.5–3 mm long, not consistently longer at base of inflorescence than at tip, glabrous to sparsely hairy. *Tepals* ± narrow-oblong, constricted below anthers, acute, 10–12 mm long, ca. 1.5 mm wide, glabrous on outside, glabrous on inside except for marginal rows of papillae below anthers; lateral flaps absent; colour not known. *Filaments* adnate to tepals, 2–3 mm long, ca. 1/4 as long as tepals. *Anthers* sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, free; colour not known; connective narrower than loculi; loculi glabrous, 5-6 mm long; appendage ± oblong, 0.3–0.5 mm long, 1/10–1/20 as long as loculi. *Gynoecium* longer than stamens, exserted, 8–10 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style with slight bend just below tip but otherwise ± straight, not ridged, capitate but otherwise tapering slightly from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* not known.

Habitat: In lateritic or stony soils, in heath.

Flowering period: December to January.

Distribution: (Fig. 20b) Eyre district: Lucky Bay and Lort River.

Conservation status: 2KC- (Briggs & Leigh 1988).

Variation: This species has been collected only twice. The two specimens differ slightly from one another in the dimensions of leaves and flower parts and in the density of epidermal papillae.

Discussion: Although Bentham (1870) synonymised *P. flexifolia* under *P. scabra* and the two species are superficially similar, they are quite distinct. They differ from one another in leaf anatomy, leaf dimensions (though their ranges overlap), and numerous flower characters including overall flower form, anther and gynoecium shape and ovule number. *P. flexifolia* is distinguished from all other species by the following combination of characters: leaves ± flat, scaberulous, mostly 1.0–2.5 cm long, 1.8–3.0 mm wide; anther connective narrower than the loculi; appendage 0.3–0.5 mm long; ovary distinctly thicker than the stipe and the base of the style.

Specimen examined: Eyre: Lort River Crossing, c. 70 km W of Esperance along road to Ravensthorpe, 33° 44' S, 121° 15' E, *B. Barnsley 410*, Jan 1979 (CBG, NSW, PERTH).

16. Persoonia graminea *R. Br.*

(Brown 1810a: 164, 1810b: 374); Sprengel (1825: 472); Meisner (1845: 533, 1856: 331); Bentham (1870: 390).

Linkia graminea (R. Br.) Kuntze (Kuntze 1891: 579).

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: ad ripas arenosas stagnorum. (ubi v.v.)'

Lectotype (here designated): on a sheet labelled 'R. Brown No. 3302 obs: s viv: Dec 1801'; annotated by Brown (BM photo NSW). The specimen on the right-hand side of the sheet is designated lectotype. Isolectotypes: BM (photo NSW), E, K (photo NSW), NSW.

Erect to decumbent weak shrub, usually branching near base, 0.2–0.6 m high, killed by fire, without spreading or extensive underground stems and with unthickened taproot. *Bark* thin. *Hairs* of medium length, appressed to antrorsely spreading, greyish. *Branchlets* angular or flattened when immature and remaining so when mature but eventually becoming terete, sparsely to moderately hairy when young but glabrescent with age. *Leaves* alternate or apparently whorled, linear, symmetrical to slightly asymmetrical, sometimes slightly twisted, flat but sometimes with slightly incurved margins, acute to acuminate, not pungent, (4–)10–35 cm long, (1–)2–8 mm wide, usually in clusters of 2–5 at end of each season's growth which are separated by long internodes, often crowded within cluster, mostly suberect to erect, often curved upwards slightly, soft and flexible, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation acrodromous; midvein evident to prominent on both surfaces; marginal veins evident to prominent; intramarginal veins evident to prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth. *Scale leaves* triangular to narrow-triangular, acute, 1–7 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal, anauxotelic, pantotonic, (1–)10–25-flowered; rachis (0–)2.5–22 cm long. *Flowers* subtended by scale leaves, regular, pendulous. *Pedicels* 2–6 mm long, sometimes slightly longer at base of inflorescence than at tip, glabrous to moderately hairy. *Tepals* ovate to lanceolate, truncate at base, not constricted below anthers, acute, 4.2–4.5 mm long, 1–1.4 mm wide, bright yellow to green, sparsely to moderately hairy on outside, glabrous on inside except for marginal rows of papillae on proximal 1/2; lateral flaps 0.1–0.3 mm wide. *Filaments* adnate to tepals except at tips, 1–1.5 mm long, 1/4–2/5 as long as tepals. *Anthers* bright yellow to green but appendages turning brown-black soon after anthesis, sublatrorse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through about 45° at appendage, free; connective narrower than loculi; loculi glabrous, 1–1.7 mm long; appendage ± narrow-oblong to ± narrow-triangular, 1.4–1.7 mm long, 4/5–7/4 as long as loculi. *Gynoecium* about as long as stamens, exserted, 3.2–4 mm long, glabrous; ovary basally

contracted into distinct stipe, conspicuously thicker than base of style; style straight, not ridged, tapering distinctly towards tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with stipe, in line with style; pyrene ellipsoid to obovoid and compressed, 4.5–6 mm long, 2–2.8 mm wide, smooth; seed 1; embryo straight; cotyledons 3.

Habitat: In poorly drained peaty to sandy or loamy soil, in heath or dry sclerophyll forest or woodland; locally common.

Flowering period: November to January.

Distribution: (Fig. 21a) Darling district: between Margaret River and Albany, within 40 km of the coast.

Conservation status: Not rare.

Variation: This species shows only minor between-individual variation in flower morphology (anther cell length: appendage length is variable). Between-population differences in flower colour are striking (bright yellow versus green) but this character is too poorly sampled to allow further discussion.

Discussion: This is a peculiar and distinctive species that does not really look much like a member of the Proteaceae at all. It is recognised easily by its weak, almost herbaceous habit, its grass-like leaves, and its pendulous flowers which are the smallest of any species in the genus and which are borne on long, leafless, anauxotelic inflorescences.

The apparent absence of *P. graminea*, between the Blackwood River catchment and Wilson's Inlet, is probably an artifact. Much of this area is remote from roads, and plants of *P. graminea* are inconspicuous and easily overlooked.

Specimens examined: Darling: Nillup via Margaret River, *R.D. Royce 40*, Jan 1945 (PERTH); Nannup-Karridale road, *R.D. Royce 3013*, Oct 1948 (PERTH); 5 km E of

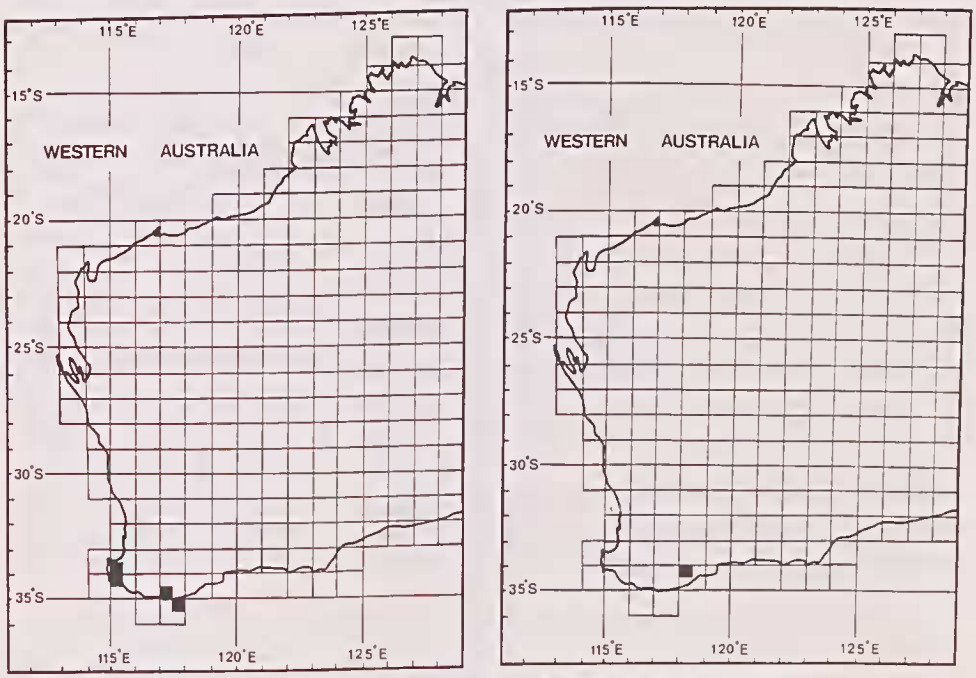

Figure 21. Distributions of **a**, *Persoonia graminea* and **b**, *Persoonia micranthera*.

Alexandra Bridge on Brockman Highway, *G.J. Keighery 968*, Nov 1976 (PERTH); Brockman Highway 5.4 km E of Great North Rd. Scott River area, *P.H. Weston 211B*, Dec 1980 (SYD, PERTH); Nannup road, *E. Wittwer 566*, Jan 1967 (CANB, KPBG); Scott River plain, 34° 15' S, 115° 22' E, *A.S. George 11772*, Jan 1974 (PERTH, SYD); Wilsons Inlet, *Oldfield 737*, (NSW); Albany, *C. Andrews s.n.*, Dec 1902 (NSW, PERTH); Princess Royal Harbour, *Preiss 725*, (PERTH).

17. Persoonia micranthera *P.H. Weston*, **sp. nov.**

Folia (2–)4–8 cm longa, (3.5–)8–30 mm lata, spathulata vel obovata vel oblanceolata. Flores regulares in inflorescentiis terminalibus vel subterminalibus anauxotelicis dispositi, bracteis squamatiformis. Gynoecium exsertum, glabrum, staminibus paulo brevius. Filamenta staminum 6.5–9 mm longa, tepalis 3/5 ad 7/10-plo longiora. Appendix antherae globula vel oblonga, 0.2–0.3 mm longa.

Holotype: Western Australia: Eyre: Summit plateau of Bluff Knoll, Stirling Range, 34° 22' S, 118° 15' E, *P.H. Weston 230*, 3 Dec 1980 (SYD). Isotypes: CANB, K, NY, PERTH.

Decumbent to prostrate shrub, usually branching from near base, 0.1–0.4 m high, killed by fire (Keighery 1993); underground parts not known. *Bark* thin. *Hairs* of medium length, appressed to patent, greyish to pale brown. *Branchlets* sometimes angular when immature but becoming terete when mature, moderately hairy when young but glabrescent after 1 year. *Leaves* alternate or opposite, spathulate or obovate or oblanceolate, symmetrical to slightly asymmetrical, often twisted at base so that most of laminae are held in ± horizontal plane, flat but with slightly recurved margins when dried, obtuse mucronate acute or acuminate, not pungent, (2–)4–8 cm long, (3.5–)8–30 mm wide, often in clusters of 2–5 at end of each season's growth which are separated by long leafless sections of stem, often crowded within cluster, patent to erect, not usually curved in dorsiventral plane, soft and flexible, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation brochidodromous; midvein evident to prominent on both surfaces; marginal veins prominent; other veins evident; epidermis smooth. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 2–8 mm long, 0.4–1.5 mm wide. *Inflorescences* terminal or rarely subterminal, anauxotelic, pantotonic, (1–)4–15-flowered; rachis (0–)1–6 cm long. *Flowers* subtended by scale leaves, regular, mostly held upright to subupright. *Pedicels* 2.5–8 mm long, longer at base of inflorescence than at tip, moderately hairy. *Tepals* ± narrow-oblong to ± oblanceolate, truncate at base, slightly constricted near base, acute, 10.5–14 mm long, 1.7–2 mm wide, yellow, moderately hairy on outside, glabrous on inside except for marginal rows of papillae on proximal 1/2; lateral flaps absent. *Filaments* adnate to tepals, 6.5–9 mm long, 3/5–7/10 as long as tepals. *Anthers* sublatrorse, ± straight, free; connective narrower than loculi; loculi glabrous, 1.8–3 mm long; appendage ± globular to ± oblong, 0.2–0.3 mm long, about 1/10 as long as loculi; colour, position of anthers with respect to one another not known. *Gynoecium* slightly shorter than stamens, exserted, 7.5–11 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style slightly curved at base but otherwise ± straight, not ridged, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to obovoid and compressed, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene ellipsoid to ovoid and compressed, 6–6.5 mm long, 3–3.3 mm wide, smooth; seed 1; embryo straight; cotyledons 3.

Derivation of epithet: From the Greek *micros*, small, and *anthera*, anther, in reference to the small size of the anthers compared to the other flower parts.

Habitat: In sandy, stony soil, in the thicket community on the summit plateau of Bluff Knoll where it is one of the few 'understorey' species; locally common.

Flowering period: February.

Distribution: (Fig. 21b) Eyre district: summit plateau of Bluff Knoll, Stirling Range.

Conservation status: 2EC-t (Briggs & Leigh 1988, as *Persoonia* sp.1).

Variation: Although variation in leaf dimensions is considerable, it appears to be no greater between individuals than within them.

Discussion: *P. micranthera* is a distinctive species, distinguished by its long staminal filaments, which are 3/5–7/10 as long as the tepals, and its basally adnate pedicels and subtending scale leaves. Other distinguishing features are the combination of wide leaves (mostly more than 9 mm wide) and anauxotelic terminal or subterminal inflorescences in which the flowers are subtended by scale leaves. It most closely resembles *P. graminea* but differs from that species in the abovementioned characters as well as in numerous others, including flower size and orientation and shape of the anther appendage.

Keighery (1993) reports that this species is pollinated by bees.

Specimens examined: Eyre: summit of Bluff Knoll, *F. Lullfitz 3270*, Feb 1964 (KPBG); top Bluff Knoll, *F. Lullfitz 3383*, Aug 1964 (KPBG, PERTH); Coyanerup Peak, *G.J. Keighery 3370*, Sep 1980 (PERTH).

18. Persoonia chapmaniana *P.H. Weston*, **sp. nov.**

Folia linearia, subteretia, pungentia, (0.5–)2–8 cm longa, 0.9–1.3 mm lata. Flores regulares. Gynoecium exsertum, stamina superans. Ovarium pilosum. Tepala glabra.

Holotype: Western Australia: Irwin: 5.5 miles [9 km] W of Winchester on Carnamah–Eneabba road, *C. Chapman s.n.*, 11 Oct 1981 (SYD). Isotypes: AD, BRI, CANB, K, MEL, NSW, NY, PERTH.

Erect, spreading shrub, branching from base, 1–2 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* short to medium length, appressed to antrorsely spreading, whitish or greyish to pale brown. *Branchlets* terete, densely hairy when young but eventually glabrescent with age. *Leaves* alternate, linear, symmetrical, not twisted, subterete with 5 longitudinal ridges, acuminate, pungent, (0.5–)2–8 cm long, 0.9–1.3 mm wide, often crowded at end of season's growth, mostly patent to suberect, often curved upwards slightly, leathery and rigid, not glaucous, concolorous, moderately to densely hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent on abaxial surface, obscure on adaxial surface; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 0.5–2 mm long, 0.3–0.5 mm wide. *Inflorescences* terminal or subterminal or axillary, anauxotelic, pantotonic, (1–)5–30-flowered; rachis (0–)1.5–6 cm long. *Flowers* subtended by scale leaves or rarely reduced leaves or leaves, regular, upright to pendulous depending on flower's position in inflorescence and on orientation of inflorescence. *Pedicels* obsolete to 5 mm long, longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to lanceolate, truncate at base, slightly constricted below anthers, acute, 5.5–11.5 mm long, 1.2–1.8 mm wide, bright yellow, glabrous; lateral flaps absent. *Filaments* adnate to tepals, 1.5–3.5 mm long, 1/5–1/3 as long as tepals. *Anthers* bright yellow, sublatrorse, held close together and close to gynoecium at their bases but

curved outwards towards tips, adnate at their bases to tepals but otherwise free; connective narrower than loculi; loculi glabrous, 2.5–4 mm long; appendage ± globular, 0.3–0.4 mm long, 1/12–1/8 as long as loculi. *Gynoecium* longer than stamens, exserted, 5–10 mm long; ovary densely covered in appressed whitish hairs, basally contracted into distinct stipe, conspicuously thicker than base of style; style hairy at base but otherwise glabrous, slightly sinuate, not ridged, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, verrucose; long axis in line with or slightly oblique to stipe, in line with or slightly oblique to style; pyrene flattened-ovate, 7.5–12 mm long, 4–5 mm wide, smooth; seed 1; embryo straight; cotyledons 6–7.

Derivation of epithet: In honour of the late Charles Chapman of Coorow. Mr Chapman collected extensively on the sand plains in the Coorow-Eneabba area. His field knowledge of this area and his *Persoonia* collections greatly assisted this study.

Habitat: In sandy soil, always in the vicinity of salt lakes, in *Eucalyptus loxophleba* woodland, heath, or more open habitats.

Flowering period: September to November.

Distribution: (Fig. 22a) Irwin and Avon districts: four isolated localities near Winchester, at Coomberdale, Lake Ninan and between Kalannie and Kulja.

Conservation status: 3V (Briggs & Leigh 1988, as *Persoonia* sp.13).

Variation: This species is poorly collected but shows no notable variation.

Discussion: *P. chapmaniana* is a distinctive species, not closely resembling any others except *P. pentasticha*, and may be distinguished readily by two diagnostic characters: verrucose drupes and 5-ribbed, subterete leaves. The combination of regular flowers, densely hairy ovary and glabrous tepals is also characteristic.

Selected specimens (14 examined): Irwin: Carnamah–Eneabba road 5.5 miles [9 km] W of

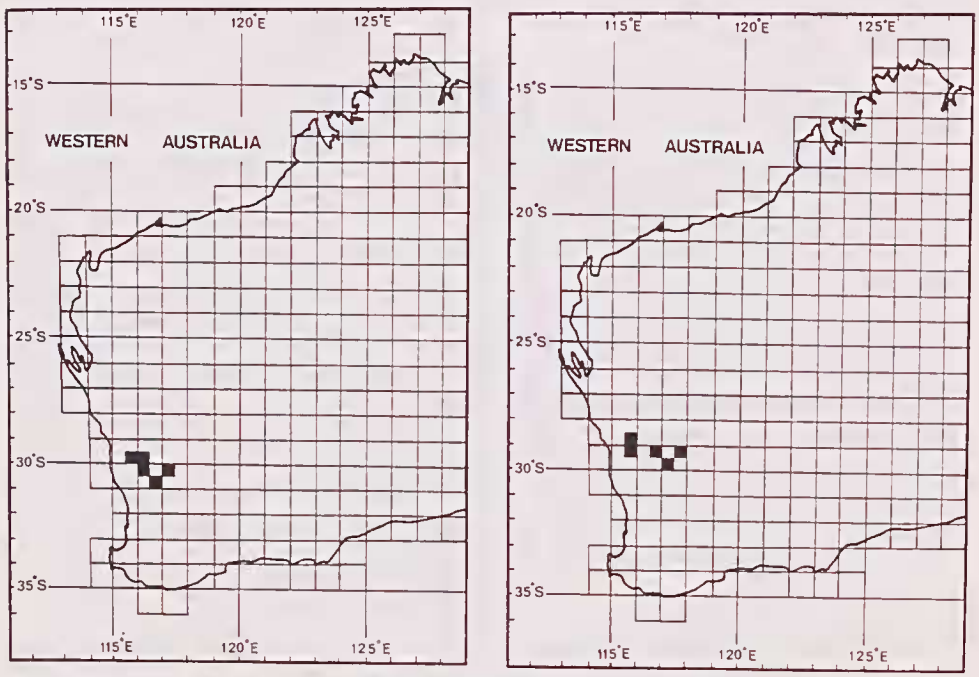

Figure 22. Distributions of **a**, *Persoonia chapmaniana* and **b**, *Persoonia pentasticha*.

Winchester, 29° 48' S, 115° 51' E, *P.H. Weston 159*, Nov 1980 (CANB, K, NSW, NY, PERTH, SYD). Avon: salt rocks on Kalannie to Kulja road, *F.W. Humphries 247*, Nov 1966 (PERTH); Coomberdale, *E. Summerville s.n.*, Sep 1949 (PERTH); Lake Ninan, 30° 57' S, 116° 37' E, *S.J. Forbes 1803*, Oct 1983 (MEL, NSW).

19. Persoonia pentasticha *P.H. Weston*, **sp. nov.**

Folia linearia, subteretia, pungentia, pentasticha, (1–)3.5–12 cm longa, 0.7–1.2 mm lata. Flores regulares. Tepala extus sparsim pubescentia. Gynoecium exsertum, stamina superans. Ovarium glabrum.

Holotype: Western Australia: Avon: 210 mile peg, north from Wubin, *J.S. Beard 2607*, 10 Aug 1963 (PERTH). Isotype: KPBG.

Erect, spreading shrub 0.4–1.8 m high; branching pattern, means of regeneration, underground parts not known. *Bark* smooth, compact; colour not known. *Hairs* short to medium length, appressed to antrorsely spreading, whitish or greyish to pale brown. *Branchlets* terete, densely hairy when young but eventually glabrescent with age. *Leaves* alternate, linear, symmetrical, not usually twisted, subterete with 5 narrow longitudinal grooves, acuminate, pungent, (1–)3.5–12 cm long, 0.7–1.2 mm wide, often crowded at end of season's growth, patent to erect, straight or curved upwards, leathery and flexible, not glaucous, concolorous, moderately to densely hairy when immature, glabrescent to moderately hairy when mature; venation parallelodromous; midvein prominent on adaxial surface; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis papillose and scabrous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 0.5–2 mm long, 0.3–0.5 mm wide. *Inflorescences* terminal or subterminal or axillary, anauxotelic, pantotonic, 1–15-flowered; rachis to 4.5 cm long. *Flowers* subtended by scale leaves, regular, upright to pendulous depending on flower's position in inflorescence and on orientation of inflorescence. *Pedicels* obsolete to 6 mm long, longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to ± narrow-elliptical, truncate at base, constricted below anthers, acute, 7–12 mm long, c. 1.5 mm wide, yellow, sparsely to moderately hairy on outside, glabrous on inside; lateral flaps absent. *Filaments* adnate to tepals, 1.5–2 mm long, c. 1/5 as long as tepals. *Anthers* yellow, sublatrorse, held close together and close to gynoecium at their bases but curved outwards towards tips, adnate at their bases to tepals but otherwise free; connective narrower than loculi; loculi glabrous, 3–5 mm long; appendage present but sometimes vestigial, ± triangular to ± globular, to 0.6 mm long, to 1/7 as long as loculi. *Gynoecium* longer than stamens, exserted, 6–9 mm long, glabrous; ovary basally contracted into distinct stipe, conspicuously thicker than base of style; style straight or sinuate to recurved at tip, not ridged, sometimes capitate and sometimes tapering from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* not known.

Derivation of name: From the Greek *penta-*, five, and *-stichos*, in a row or a line, in reference to the subterete leaves with 5 longitudinal grooves.

Habitat: In sand, laterite, weathered granite or red loam, in heath.

Flowering period: August to November.

Distribution: (Fig. 22b) Avon and Austin districts: an area roughly bounded by Mullewa, Mingenew, Wubin and Paynes Find.

Conservation status: 3K (Briggs & Leigh 1988, as *Persoonia* sp.8).

Variation: Variation is evident between specimens in leaf and flower dimensions, but this does not appear to be geographically correlated.

Discussion: *P. pentasticha* closely resembles *P. chapmaniana* and together they may be distinguished by their subterete, 5-ribbed leaves. *P. pentasticha* differs from *P. chapmaniana* in having slightly narrower, more flexible, more densely papillose leaves with much narrower grooves between the ribs, usually shorter, fewer-flowered inflorescences and a glabrous gynoecium.

Selected specimens (11 examined): Avon: 6 miles [10 km] from Mullewa, towards Pindar, *M.E. Phillips 1623*, Sep 1962 (CBG, PERTH n.v.); 'Carranya' property, c. 15 km direct NW of Morawa, 29° 05' S, 115° 55' E, *J. White s.n.*, Oct 1986 (PERTH); Ebano, Mingenew, *W.D. Campbell 85*, Nov 1907 (K); 29.6 miles [47 km] NE of No. 2 Rabbit Fence on Wubin to Paynes Find road, 29° 41' S, 117° 06' E, *B.H. Smith 1057*, Aug 1988 (NSW). Austin: 4.4 miles [7 km] E of Paynes Find on road to 'Maranalgo' (c. 0.5 miles [c. 0.8 km] N of road), 29° 17' 15" S, 117° 44' 15" E, *B.H. Smith 1483*, Aug 1991 (NSW); 20 km S of Paynes Find, *P.M. Olde 88/80*, Oct 1988 (NSW).

20. Persoonia trinervis *Meisn.*

[Meisner (1852: 185) nom. nud.] (Meisner 1856: 332); Bentham (1870: 386).

Linkia trinervis (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'In colonia Swan River (Drumm. coll. 5, suppl. n. 5!) ... (v.s. in herb. Lemann.)'

Lectotype (here designated): a sheet labelled by Meisner '5 (suppl. to 5th coll.) Persoonia trinervis Meisn. S.W. Australia Drummond (herb. Lemann)' (NY). Isolectotypes: BM, CGE (photo NSW), Fl, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, NSW, PERTH, TCD.

P. tortifolia Meisn. [Meisner (1852: 185) nom. nud.] (Meisner 1856: 331); Bentham (1870: 386). *Linkia tortifolia* (Meisn.) Kuntze (Kuntze 1891: 579). Type citation: 'In colonia Swan River (Drumm. coll. 4, n. 272!) ... (v.s. in herb. Shuttl.)'. **Lectotype (here designated):** a sheet labelled by Meisner 'Persoonia tortifolia nob. (30.Jun.1850) Swan River legit Drummond, n. 272! D. am. Shuttleworth 11.Oct.1853' (NY). Isolectotypes: BM, CGE, E, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL (2 sheets), NSW, PERTH (n.v.), TCD.

Erect, sometimes spreading shrub, with single main stem or with several to many stems branching from below ground level, 0.3–1.8 m high, regenerating after disturbance from lignotuber, without spreading or extensive underground stems but with thickened taproot. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to patent, greyish to ferruginous. *Branchlets* terete, densely hairy when young but eventually glabrescent with age. *Leaves* alternate, spathulate to linear-spathulate or oblanceolate to linear-oblanceolate or rarely linear-oblong, symmetrical or slightly asymmetrical, often twisted to 2 turns, flat or undulate or concave or rarely dorsiventrally compressed, acute or acuminate or obtuse or mucronate, not pungent, (0.7–)1.5–7 cm long, 3–10(–20) mm wide, sometimes crowded at end of season's growth, patent to erect, often curved upwards slightly or curved to coiled downwards slightly to prominently towards tip, leathery and rigid to flexible, not glaucous, ± concolorous or 6 main veins paler in colour than rest of lamina, moderately to densely hairy when immature, usually glabrescent when mature though sometimes retaining sparse to moderate cover of hairs; venation acrodromous or parallelodromous; midvein evident to prominent on both surfaces; marginal veins evident to prominent; intramarginal veins evident to prominent on abaxial surface, obscure on adaxial surface; other veins obscure to evident; epidermis papillose and scaberulous to scabrous. *Scale leaves* triangular to narrow-triangular, acute, 1.5–5 mm long, 0.7–1 mm wide. *Inflorescences* terminal or subterminal or axillary, anauxotelic or rarely auxotelic, pantotonic or basitonic, 1–4-flowered; rachis to 0.1 cm long. *Flowers*

subtended by scale leaves, regular, mostly held upright to subupright. *Pedicels* 1–3.5 mm long, not consistently longer at base of inflorescence than at tip, densely hairy. *Tepals* ± narrow-oblong to ± lanceolate or ± oblanceolate and sometimes attenuate at tip, truncate at base, often slightly constricted below anthers, acute to acuminate, 8.5–16 mm long, 1.5–2.2 mm wide, yellow, densely hairy on outside, glabrous on inside; lateral flaps to 1 mm wide. *Filaments* adnate to tepals except at tips, 2.5–4.5 mm long, 1/5–2/5 as long as tepals. *Anthers* yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but slightly or abruptly reflexed to 180° at appendage, free; connective as wide as or slightly wider than loculi; loculi glabrous, 3.5–5.5 mm long; appendage ± triangular to narrow-triangular or narrow-oblong, 0.3–3.5 mm long, 1/14–4/5 as long as loculi. *Gynoecium* longer than stamens, exserted, 8–13 mm long; ovary densely covered in antrorsely spreading hairs which are greyish basally but ferruginous distally, basally contracted into distinct stipe, conspicuously thicker than base of style; style glabrous, straight, not ridged, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* obovoid, smooth; long axis in line with stipe, in line with style; pyrene obovoid, 8–9 mm long, about 4 mm wide, smooth; seed 1; embryo straight; cotyledons 7.

Habitat: In white or yellow sand or loam, often over laterite, in low heath or mallee-heath to mallee-woodland; usually in small populations or occurring as isolated individuals.

Flowering period: September to December.

Distribution: (Fig. 23a) South-western Australia: an area roughly bounded by Mt Peron, Narrogin, Lake Grace, Frank Hann National Park and Watheroo.

Conservation status: Not rare.

Variation: This is an extremely variable species, particularly with respect to leaf morphology, which varies greatly even within individuals. Geographically correlated variation is evident in indumentum, leaf morphology, flower size, tepal morphology and anther appendage morphology. The extremes of variation may be characterised as follows: southern form (Frank Hann National Park – Lake Grace – Popanyinning area): hairs appressed to antrorsely spreading; leaves spathulate to linear-spathulate or oblanceolate to linear, concave and occasionally undulate, sometimes twisted to 1/2 a turn, often prominently curved or coiled downwards towards the tip, mostly 1.5–7 cm long, 4–10 mm wide; tertiary veins evident; tepals not attenuate at the tip, 8.5–12 mm long; anther appendage triangular, 0.3–0.7 mm long, 1/14–1/7 as long as the loculi; western form (Mogumber area): hairs antrorsely spreading to patent; leaves linear to linear-spathulate, dorsiventrally flattened to compressed, mostly 3–9 cm long, 1.6–3 mm wide, occasionally twisted to 1/2 a turn, if curved downwards at the tip then only slightly so; tepals slightly attenuate at the tip, 12–13 mm long; anther appendage triangular, 0.5–1 mm long, 1/10–1/4 as long as the loculi; northern form (Coomallo Creek – Watheroo area): hairs antrorsely spreading to patent: leaves narrow-spathulate, flat or slightly concave, mostly 2–6 cm long, 4–10(–20) mm wide, mostly twisted through 1/4–1 turn, curved downwards at the tip; tepals prominently attenuate at the tip, 12–16 mm long; anther appendage narrow-triangular to narrow-oblong, 2–3.5 mm long, 1/2–4/5 as long as the loculi. These extremes grade into one another in the intervening areas. Two varieties were segregated by C. Gardner (as shown by annotated herbarium sheets) from the type variety on the basis of their novel leaf morphology. These were published (though not validly so) by Blackall & Grieve (1954). Their variety *angustifolia* corresponds to the extreme western form mentioned above, but since this intergrades gradually into the other forms, I have not recognised it as a distinct taxon. Their variety

crispata is represented by a single specimen with undulate leaves belonging to the southern form. It appears to be an aberrant individual. *P. tortifolia* Meisn. is based on a single collection, which, apart from its unusually strongly twisted leaves, falls within the range of variation of *P. trinervis*. In all other characters it occupies a position intermediate between the extreme variants described above. I have therefore included it within *P. trinervis*.

Discussion: *P. trinervis* is distinguished from all other species by the following combination of characters: leaves mostly wider than 2 mm, with 3 prominent ridges on the undersurface; flowers regular; anther appendages present; ovary densely hairy. It most closely resembles *P. papillosa* and *P. angustiflora* but differs from the former in having much shorter, fewer-flowered inflorescences in which the flowers are subtended by scale leaves. It differs from the latter species as noted in the discussion of that species. *P. trinervis* has been misidentified frequently as *P. rufiflora*. It differs from that species in numerous characters, including its densely hairy ovary and the 3 ridges on the undersurface of the leaves.

Selected specimens (34 examined): Irwin: Coomallo Ck, 30° 13' S, 115° 25' E, *P.H. Weston 279*, Dec 1980 (SYD, PERTH). Darling: c. 2 miles [3 km] E along Mogumber road from Brand Highway, *A.S. George 9650*, Oct 1969 (PERTH 2 sheets); 70 km S of Moora, 31 05' S, 116 12' E, *D.J.E. Whibley 4999*, Nov 1974 (AD). Avon: near Korrelocking, *C.A. Gardner s.n.*, Oct 1963 (PERTH); Quairading–Corrigin road, 32 17' S, 117 45' E, *A.S. George 12919*, Oct 1974 (PERTH 2 sheets); West Popanyinning, *F. Lullfitz 1728*, Nov 1962 (KPBG, PERTH). Roe: Bendering, *C.A. Gardner 1525*, Nov 1923 (PERTH); 10 km SE of Mt Gibbs, Frank Hann National Park, *K. Newbey 6499*, Nov 1979 (PERTH); Baanga Hill, *E.M. Canning s.n.*, Nov 1968 (CBG, NSW).

21. Persoonia angustiflora *Benth.*

(Bentham 1870: 386); Weston (1987: 348).

Linkia angustiflora (Benth.) Kuntze (Kuntze 1891: 579).

Type citation: 'W.A. Swan River, Drummond, 1st coll. n.597, Preiss, n. 729'.

Lectotype (here designated): a sheet labelled 'Swan River. N.Holland. Drummond. 597' (K, photo NSW). Isolectotypes: BM, K, MEL. Residual syntypes: (Drummond s.n.) K (2 sheets); (Preiss 729) FI, G (n.v., photo NSW), G-DC (n.v., photo NSW), MEL, NY.

P. angustiflora Benth. var. *burracoppinensis* D.A. Herb. (Herbert 1921: 88). Type citation: 'Collectors: Herbert & Wilson, No.100. Locality: Burracoppin. Date: November 1920.' Holotype: PERTH.

Misapplied name: *P. fraseri* auct. non R. Br.: Meisner (1845: 532, 1856: 334).

Erect, occasionally spreading shrub, with single main stem or with several to many stems branching from below ground level, 0.2–1.8 m high, regenerating after disturbance from lignotuber, without spreading or extensive underground stems but with thickened taproot. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish to mid-brown. *Branchlets* often angular when immature but usually becoming terete when mature, moderately to densely hairy when young but eventually glabrescent with age. *Leaves* alternate, linear, symmetrical or slightly asymmetrical, not twisted, dorsiventrally compressed to subterete with 6 longitudinal grooves and ridges, acuminate, not pungent, (0.8–)2–13 cm long, 0.7–1.3 mm wide, often crowded on short lateral branchlets and at end of season's growth, mostly suberect to erect, often curved upwards slightly, leathery and flexible to rigid, not glaucous, concolorous, moderately to densely hairy when immature, usually glabrescent when mature though sometimes hairs in grooves persistent; venation

parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 0.9–3.5 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or anauxotelic, basitonic or pantotonic, 1–4-flowered; rachis usually less than 0.1 cm long. *Flowers* subtended by scale leaves or very rarely reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 2.5–12 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to ± lanceolate, truncate at base, usually constricted below anthers, acuminate, 9–16 mm long, 1.3–2 mm wide, greenish-yellow, moderately to densely hairy on outside, glabrous on inside; lateral flaps to 0.3 mm wide. *Filaments* adnate to tepals except at tips, 2–4 mm long, 1/3–1/5 as long as tepals. *Anthers* greenish-yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but slightly or abruptly reflexed to 180° at appendage, free; connective as wide as to slightly wider than loculi; loculi glabrous, 3–5.5 mm long; appendage ± globular or ± triangular or ± oblong to ± narrow-oblong, 0.3–3 mm long, 3/5–1/10 as long as loculi. *Gynoecium* longer than stamens, exserted, 7.5–12.5 mm long; ovary densely covered in antrorsely spreading hairs which are greyish basally but ferruginous distally, basally contracted into distinct stipe, conspicuously thicker than base of style; style glabrous, straight, not ridged, capitate but otherwise constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with stipe, in line with style; pyrene ellipsoid to obovoid, 6.5–9 mm long, 2.5–3.5 mm wide, smooth; seed 1; embryo straight; cotyledons 4–5.

Habitat: In white, grey, or yellow sand or loam, often over laterite, in low heath or mallee-heath to mallee-woodland or in *Eucalyptus calophylla* or *E. marginata* woodland or in *Banksia* woodland; usually in small populations or occurring as isolated individuals.

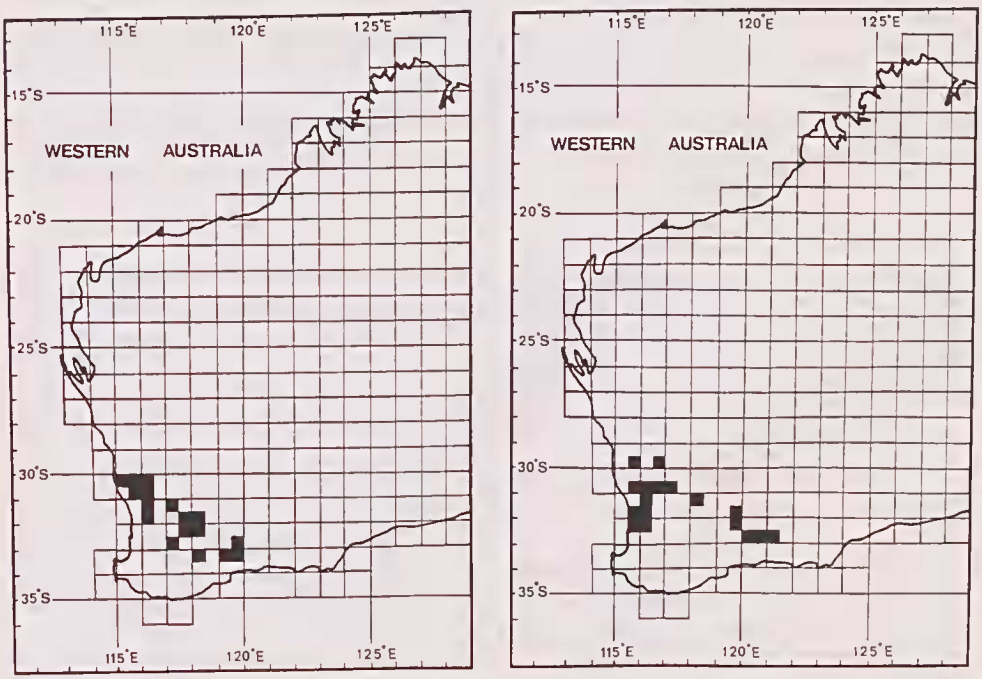

Figure 23. Distributions of **a**, *Persoonia trinervis* and **b**, *Persoonia angustiflora*.

Flowering period: September to March.

Distribution: (Fig. 23b) South-western Australia: an area roughly bounded by Eneabba, Perth, Frank Hann National Park and Maya.

Conservation status: Not rare.

Variation: This widespread species shows geographically correlated variation in leaf length, leaf cross-sectional shape, pedicel length, flower size, anther appendage length, ratio of anther appendage length to anther locule length. Three extremes of variation in these characters may be described as follows. Western form (Perth area, coastal plain): leaves mostly 5–14 cm long, dorsiventrally compressed; pedicels 2.5–7 mm long; tepals 12–16 mm long, anther appendage 1.5–3 mm long, 3/10–3/5 as long as the loculi. Eastern form (Frank Hann National Park – Merredin area): leaves mostly 2–5 cm long, subterete, pedicels 5–9 mm long; tepals 9–10 mm long, anther appendage 0.3–0.6 mm long, 1/5–1/10 as long as the loculi. Northern form (Maya – Coorow area): leaves mostly 4–7 cm long, dorsiventrally compressed; pedicels 1.5–7 mm long; tepals 9–11 mm long; anther appendage 0.3–0.6 mm long, 1/5–1/10 as long as the loculi. The range of variation is found linking these extremes. The 'eastern form' includes the type of *P. angustiflora* var. *burracoppinensis* D.A. Herb. but I have not recognised this as a distinct taxon because it cannot be diagnosed reliably using any combination of characters.

Discussion: *P. angustiflora* is distinguished from all other species by the following combination of characters: leaves linear, dorsiventrally compressed to subterete, with 6 longitudinal grooves and ridges, not pungent, (1.5–)2–13 cm long, 0.7–1.3 mm wide; inflorescences 1–4-flowered; rachis usually less than 0.1 cm long; flowers regular; anther appendage present. It closely resembles *P. papillosa* and some forms of *P. trinervis*. It may be distinguished from the former by the abovementioned inflorescence characters and from the latter by its narrower leaves and its more appressed hairs.

Selected specimens (43 examined): Irwin: c. 13 km W of Coorow, c. 29° 54' S, 115° 54' E, *C. Chapman s.n.*, Oct 1979 (SYD). Darling: Gillingarra, *E.W. Hursthouse s.n.*, Apr 1903 (NSW); Hale Road Forrestfield, *R.J. Cranfield 266/77*, Nov 1977 (PERTH); Julimar Brook, *D.H. Perry s.n.*, Oct 1945 (PERTH). Avon: 4.5 km S of Maya, 29° 54' S, 116° 31' E, *P.H. Weston 307*, Dec 1980 (SYD); 6 miles [10 km] E of Ballidu, *R.D. Royce 1221*, Sep 1946 (PERTH); Burracoppin, *E.H. Wilson & D.A. Herbert s.n.*, Nov 1922 (PERTH). Roe: 10 km N of Mt Holland, *G.J. Keighery 1078*, Oct 1977 (KPBG); Frank Hann National Park, 32° 49' S, 120° 30' E, *K. Newbey 6848*, Aug 1980 (PERTH).

22. Persoonia papillosa *P.H. Weston*, **sp. nov.**

Folia linearia, (0.6–)1.5–3 cm longa, 1–1.3 mm lata, papillosa, scabra, dorsiventraliter complanata, canalibus longitudinalibus 6. Rhachis ad 6 cm longa. Flores regulares. Tepala extus pilis densis. Gynoecium exsertum, stamina superans. Ovarium pilis dense obtectum.

Holotype: Western Australia: Irwin: SW of Yuna, *F.W. Went 88*, 8 Sep 1962 (PERTH).

Erect shrub, about 0.3 m high; branching structure, means of regeneration, underground parts not known. *Bark* not known. *Hairs* of medium length, appressed to patent, mid-brown. *Branchlets* slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, often slightly asymmetrical, not twisted, dorsiventrally compressed with 6 longitudinal grooves and ridges, acuminate, not pungent, (0.6–)1.5–3 cm long, 1–1.3 mm wide, often crowded, mostly erect, often curved upwards slightly, leathery and rigid, not glaucous, concolorous, moderately to densely hairy when immature, glabrescent or retaining sparse cover of hairs when mature;

venation parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis papillose and scabrous. *Scale leaves* triangular, acute, 1–3 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic, 1–20-flowered; rachis to 6 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 6–14 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to ± lanceolate, truncate at base, constricted below anthers, acuminate, 9.5–11 mm long, 1.5–2 mm wide, densely hairy on outside, glabrous on inside; lateral flaps absent; tepal colour not known. *Filaments* adnate to tepals except at tips, 2–2.5 mm long, 1/5–1/4 as long as tepals. *Anthers* introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 180° at appendage, free; connective slightly wider than loculi; loculi glabrous, 3.5–4 mm long; appendage ± oblong, 1–1.3 mm long, 1/4–1/3 as long as loculi. *Gynoecium* longer than stamens, exserted, 8–9 mm long; ovary densely covered in antrorsely spreading hairs which are greyish basally but ferruginous distally, basally contracted into distinct stipe, conspicuously thicker than base of style; style glabrous, straight, sometimes with 8 rather obscure longitudinal ridges, ± constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* not known.

Derivation of epithet: Latin, *papillosus*, papillose, in reference to the papillose, scabrous leaves.

Habitat: In sand.

Flowering period: September to January.

Distribution: (Fig. 24a) Irwin district of Western Australia: Murchison River to the Yuna area.

Conservation status: 2K (Briggs & Leigh 1988, as *Persoonia* sp.14).

Variation: This species is poorly sampled and the two specimens differ only in indumentum type. *C.A. Gardner 12059* has appressed to antrorsely spreading hairs while those of *Went 88* are antrorsely spreading to patent.

Discussion: *P. papillosa* closely resembles *P. angustiflora* and some forms of *P. trinervis*. It is distinguished from both of these species by its inflorescences which have up to 20 flowers with rachises up to 6 cm long (mostly longer than 0.2 cm) and flowers often subtended by leaves. It also differs from *P. angustiflora* in its more densely papillose, scabrous leaves and from *P. trinervis* in its narrower, linear-oblong leaves. It is distinguished from all other species by the combination of regular flowers, ovary which is densely covered in antrorsely spreading hairs and by its non-pungent leaves. It is possible that the morphological gap between *P. angustiflora* and *P.papillosa* could be an artefact due to inadequate sampling of the area separating their distributions. This seems unlikely, however, since this area is easily accessible and if intermediates did exist there they would probably have been collected.

Specimen examined: Irwin: Murchison River, *C.A. Gardner 12059*, Jan 1959 (PERTH).

23. Persoonia bowgada *P.H. Weston*, **sp. nov.**

Folia linearia, subteretia, pungentia, (2.5–)5–11 cm longa, 0.7–1.3 mm lata, canalibus sex angustis longitudinalibus. Flores regulares. Antherae tepala ad basim adnatae. Appendix antherae 1–2 mm longa, oblonga vel anguste triangularis. Gynoecium exsertum, stamina aequans. Ovarium pilis appressis dense obtectum, stylum aequans vel angustius.

Holotype: Western Australia: Carnarvon: Between Coolcalalaya Stn. and Glasse's Bore, *J.S. Beard 7142*, 22 Oct 1974 (PERTH).

Erect, spreading shrub with several to many stems branching near base, 1–3.5 m high; means of regeneration, underground parts not known. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish to pale brown. *Branchlets* sometimes slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent after 1 or 2 years. *Leaves* alternate, linear, symmetrical to slightly asymmetrical, sometimes twisted to 1/2 complete turn, subterete with 6 narrow longitudinal grooves, acuminate, pungent, (2.5–)5–11 cm long, 0.7–1.3 mm wide, often crowded at end of season's growth, mostly suberect to erect, often curved upwards slightly, leathery and rigid to rather flexible, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth. *Scale leaves* narrow-triangular, acute to acuminate, 2.2–4.2 mm long, 0.6–1.2 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or occasionally anauxotelic, basitonic, 1–10-flowered; rachis to 4 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 2.5–7 mm long, often slightly longer at base of inflorescence than at tip, densely hairy. *Tepals* ± narrow-oblong but attenuate at tip, constricted below anthers, acute to acuminate, 11–15.5 mm long, 2–2.5 mm wide, yellow, moderately to densely hairy on outside, glabrous on inside except for marginal rows of papillae below anthers; lateral flaps to 0.5 mm wide. *Filaments* adnate to tepals, 2–3.5 mm long, 1/6–1/4 as long as tepals. *Anthers* yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 180° at appendage, adnate to tepals for about lower 1/5–1/4 of loculi; connective about as

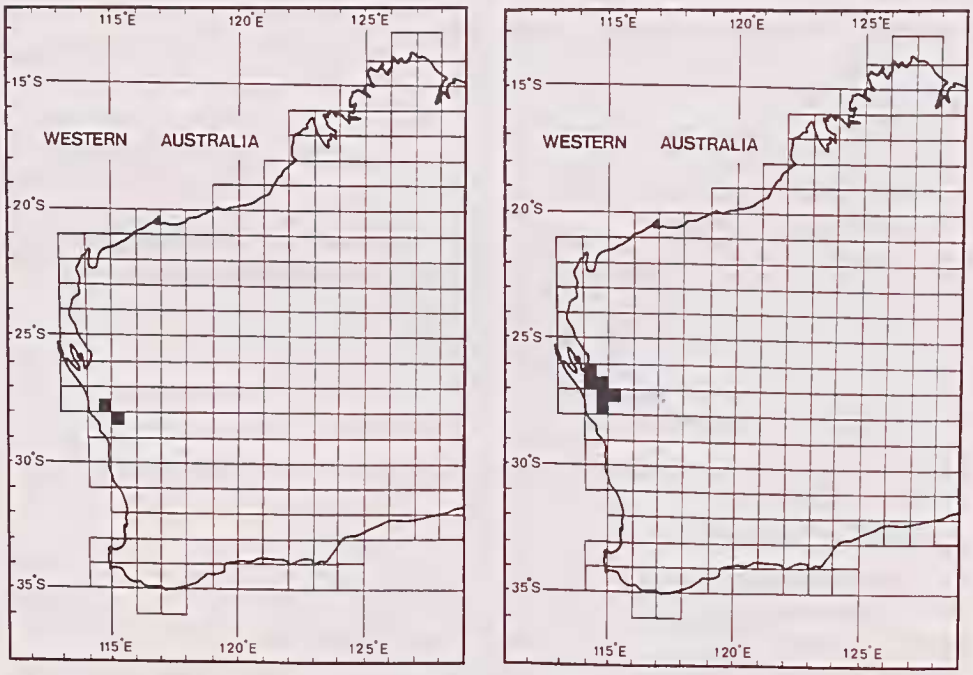

Figure 24. Distributions of **a**, *Persoonia papillosa* and **b**, *Persoonia bowgada*.

wide as loculi; loculi glabrous, 5.5–7.5 mm long; appendage ± oblong to narrow-triangular, 1–2 mm long, 1/3–1/5 as long as loculi. *Gynoecium* about as long as or longer than stamens, exserted, 10–12 mm long; ovary densely covered in appressed greyish hairs, not contracted at base, no thicker than base of style; style glabrous or with few scattered hairs, straight, with 8 conspicuous longitudinal ridges, slightly capitate but otherwise ± constant in thickness or tapering slightly from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to narrow-ellipsoid, smooth; long axis in line with stipe, in line with style; pyrene ellipsoid narrow-ellipsoid or obovoid, 10–14.5 mm long, 4–7 mm wide, smooth; seed 1; embryo straight; cotyledons 4–7.

Derivation of epithet: In reference to 'bowgada scrub', a plant community dominated by *Acacia linophylla* or 'bowgada', in which this species frequently occurs. This species also superficially resembles *Acacia linophylla* in habit and leaf morphology.

Habitat: Most frequently in red sand or sandy loam but also found in yellow sand and ironstone, most frequently in *Acacia* woodland but also found in *Eucalyptus* woodland or mallee-heath and in *Acacia–Allocasuarina* scrub; common throughout its range.

Flowering period: October to November.

Distribution: (Fig. 24b) Irwin and Carnarvon districts: between Shark Bay and the Murchison River, within 100 km of the coast.

Conservation status: Not rare.

Variation: There is no conspicuous variation apparent in this species.

Discussion: This species is distinguished by the following combination of characters: leaves linear, subterete, with 6 narrow grooves, pungent; flowers regular; filaments entirely adnate to the tepals; appendages oblong to narrow-triangular; ovary densely covered with appressed hairs. It most closely resembles *P. hexagona* but differs from that species in its non-striate leaves (when dried) and densely hairy ovary. It resembles *P. augustiflora* but is distinguished from that species by its pungent leaves, appressed hairs on the ovary and filaments entirely adnate to the tepals.

One specimen, *Craven 7112*, from north of Pindar, is morphologically intermediate between *P. bowgada* and *P. hexagona*, having the foliage of typical *P. bowgada* and flowers resembling those of typical *P. hexagona*. Its collection locality is well south of the area around the lower Murchison River where one might expect to find hybrids or any zone of intergradation between these species. Clearly, more collections are required from the area north of Mullewa to clarify the pattern of geographic variation. Further sampling might show that *P. bowgada* and *P. hexagona* are not specifically distinct.

Selected specimens (12 examined): Irwin: Hamelin Pool, *F. Lullfitz 2839*, Oct 1963 (KPBG, PERTH); Tamala road 2.0 km WSW of junction with Denham road, 26° 29' S, 114° 03' E, *P.H. Weston 290*, Dec 1980 (SYD); 23 km from 'Coburn' to 'Hamelin', 26° 35' S, 114° 10' E, *D.F. Blaxell W75/103*, Oct 1975 (NSW); 30 km S of Billabong Roadhouse on North West [Coastal] Highway, 27° 04' S, 114 38' E, *S.J. Forbes 1651*, Oct 1983 (MEL, NSW); North West Coastal Highway 32.2 km N of Murchison River, *P.H. Weston 288*, Dec 1980 (SYD). 7 miles [11 km] N of Murchison River, North West Coastal Highway, *A.S. George 7870*, Sep 1966 (PERTH).

P. bowgada – *P. hexagona* intermediate: Avon: 7 km N of Pindar along Boolardy Stn. road, 28° 26' S, 115° 50' E, *L.A. Craven 7112*, 14 Oct 1981 (CANB, NSW).

24. Persoonia hexagona *P.H. Weston*, **sp. nov.**

Folia (2.5–)5–13 cm longa, 0.7–1.3 mm lata, linearia, subteretia, pungentia, canalibus sex. Flores regulares. Appendix antherae anguste triangularis vel anguste oblonga, 1–1.7 mm longa, reflexa. Gynoecium glabrum vel sparsim pilosum, stamina aequans vel superans. Ovarium basin styli aequans.

Holotype: Western Australia: Avon: Road from Perenjori to Paynes Find via Warriedar, 3.2 km W of turn-off to Karara, 29° 20' S, 116° 40' E, *P.H. Weston 182*, 26 Nov 1980 (SYD). Isotypes: CANB, K, NSW, NY, PERTH.

P. angustiflora Benth. var. *pedicellaris* Benth. (Bentham 1870: 387). Type citation: 'Murchison River, Oldfield.' Possible syntypes: 2 sheets labelled *'Persoonia fraseri* R.Br. var. Murchison R. W.A. Oldf.' (MEL). Bentham's specimen could not be found at K.

Erect, spreading shrub with several to many stems branching near base, 1–3.5 m high; means of regeneration, underground parts not known. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish to pale brown. *Branchlets* terete, densely hairy when young but glabrescent after 2 or 3 years. *Leaves* alternate, linear, symmetrical or slightly asymmetrical, sometimes twisted to 1/2 complete turn, subterete with 6 longitudinal ridges, acuminate, pungent, (2.5–)5–13 cm long, 0.7–1.3 mm wide, often crowded at end of season's growth, mostly suberect to erect, often curved upwards slightly, leathery and rigid to rather flexible, not glaucous, ridges much paler in colour than grooves when dried giving leaf prominently striated appearance, sparsely to moderately hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure: epidermis slightly papillose but ± smooth to touch. *Scale leaves* narrow-triangular, acute, 1.4–4 mm long, 0.7–0.8 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or rarely anauxotelic, basitonic, 1–10-flowered; rachis to 4 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 7.5–9 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± lanceolate to ± narrow-elliptic and often attenuate at tip, truncate at base, slightly constricted below anthers, acute to acuminate, 10.5–20 mm long, 1.4–2.2 mm wide, bright yellow, sparsely to moderately hairy on outside, glabrous on inside; lateral flaps 0.3–0.6 mm wide. *Filaments* adnate to tepals, 1.4–3.2 mm long, 1/5–1/8 as long as tepals. *Anthers* bright yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 180° at appendage, free or adnate to tepals to lower 1/3 of loculi; connective about as wide as loculi; loculi glabrous, 5–6 mm long; appendage ± narrow-triangular to ± narrow-oblong, 1–1.7 mm long, 1/3–1/5 as long as loculi. *Gynoecium* about as long as or longer than stamens, exserted, 8.5–12.5 mm long, glabrous to sparsely hairy; ovary not contracted at base, no thicker than base of style; style straight, with 8 conspicuous longitudinal ridges, slightly capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene ellipsoid, 8–14 mm long, 4–5.5 mm wide, smooth; seed 1; embryo straight; cotyledons 4–7.

Derivation of epithet: From the Greek *hexagonos*, six-angled, in reference to the six-angled, subterete leaves.

Habitat: Most frequently on red sand or sandy loam but also found on yellow sand or stony hillsides, most frequently in *Acacia* woodland but also found in communities dominated by *Casuarina* or *Eucalyptus*; often locally common.

Flowering period: November to December.

Distribution: (Fig. 25a) Irwin and Avon districts: from the Murchison River SE to the Perenjori area.

Conservation status: Not rare.

Variation: This species is a coherent one showing only minor between-individual variation in flower size, the degree of tepal-tip attenuation and in the density of ovary hairs.

Discussion: Dried specimens of this species may be recognised easily by the characteristically striated, 6-ribbed, linear, subterete, pungent leaves which are (2.5–) 5–13 cm long, 0.7–0.8 mm wide. The striations are due to the absence of stomata from the ribs. When dried, the stomatal guard cells turn black, rendering the grooves much darker than the ribs. This species most closely resembles *P. bowgada* but differs from it in its striate leaves and in its glabrous to sparsely hairy ovary.

Selected specimens (9 examined): Irwin: Z bend, Murchison River, *A.C. Burns 19*, Jun 1969 (PERTH); 4 miles [6 km] N of Howatharra, *G.J. Keighery 185*, Nov 1974 (KPBG, PERTH). Avon: 24.3 km SW of Morawa P.O. towards Three Springs, 29° 19' S, 115° 53' E, *R. Coveny 7963 & B.R. Maslin*, Sep 1976 (NSW); road to Karara, 1.0 km E of rabbit-proof fence, 29° 23' S, 116° 37' E, *P.H. Weston 183*, Nov 1980 (SYD).

25. Persoonia spathulata R. Br.

(Brown 1810a: 162, 1810b: 373); Sprengel (1825: 473); Meisner (1856: 338); non Sieber ex Schult. & f. (Schultes & Schultes 1827).

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: in collibus saxosis. (ubi v.v.)'

Lectotype (here designated): a sheet labelled 'R. Brown No. 3280 Bay I South Coast'; annotated by Brown (BM, photo NSW). Three specimens are mounted at the top of this sheet. The middle specimen is designated lectotype. The right-hand specimen is labelled (not by Brown) '*Persoonia flexifolia* South Coast' but is a good match with the other two specimens. It is obviously not part of the type material of *P. flexifolia* R. Br.

Erect, spreading shrub with many stems branching from below ground level, 0.2–0.6 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, grey. *Hairs* of 2 distinct types that mostly occur mixed together: (i) medium length, greyish or whitish, non-glandular hairs that are incurved-patent on young branchlets and pedicels but antrorsely spreading on other organs; (ii) short, brown, patent, glandular hairs. *Branchlets* terete, moderately to densely hairy when young but glabrescent after 2 years. *Leaves* alternate, mostly spathulate to narrow-spathulate or sometimes oblanceolate or narrow-elliptical, symmetrical to slightly asymmetrical, usually twisted at base so that lamina is held in ± vertical plane, flat, mucronate to acuminate, sharp but not pungent, (0.7–)1.5–3.8 cm long, 5–10 mm wide, usually crowded at end of season's growth and occasionally on lateral short shoots, mostly suberect to erect, sometimes slightly incurved, leathery and rigid, not glaucous, concolorous, moderately hairy when immature, glabrescent when mature; venation acrodromous to brochidodromous; midvein evident to prominent on both surfaces; marginal veins absent; intramarginal and other veins evident on both surfaces; epidermis densely papillose and scabrous. *Scale leaves* triangular, acute, 2–3.5 mm long, 0.4–1.0 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic, 1–2-flowered; rachis to 0.2 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 3.5–9 mm long, not consistently longer at base of inflorescence than at tip,

moderately hairy. *Tepals* ± lanceolate, contracted below anthers, acute, 9–13 mm long, c. 2 mm wide, yellow, moderately covered with glandular hairs but with no non-glandular hairs on outside, glabrous on inside except for marginal patches of papillae just below anthers; lateral flaps to 0.2 mm wide. *Filaments* adnate to tepals, 2–3 mm long, 1/5–1/4 as long as tepals. *Anthers* yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but reflexed through 90°–180° at appendage, adnate to tepals for lower 1/6–1/2 of loculi; connective as wide as or slightly wider than loculi; loculi glabrous, 3.5–6 mm long; appendage ± oblong, c. 2 mm long, 1/3–4/7 as long as loculi. *Gynoecium* about as long as stamens, exserted, 7–11 mm long, glabrous; ovary slightly contracted at base, no thicker than base of style; style straight, with 8 obscure to conspicuous longitudinal ridges, tapering gradually from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with stipe, in line with style; pyrene not known.

Habitat: Sand heath; locally occasional.

Flowering period: December to January.

Distribution: (Fig. 25b) Roe and Eyre districts: an area roughly bounded by Dingo Rock, Cape Le Grand and Israelite Bay.

Conservation status: 3K (proposed here).

Variation: Only four collections have been made since Robert Brown collected the type and although these show variation in leaf shape and tepal size it is unclear whether this is geographically correlated.

Discussion: This species closely resembles the spathulate-leaved specimens of *P. scabra* and it is not surprising that Bentham (1870) synonymised the two species. However, *P. spathulata* is clearly distinguished from all other species of Persooniinae by its indumentum consisting of a mixture of glandular and non-glandular hairs. It is also

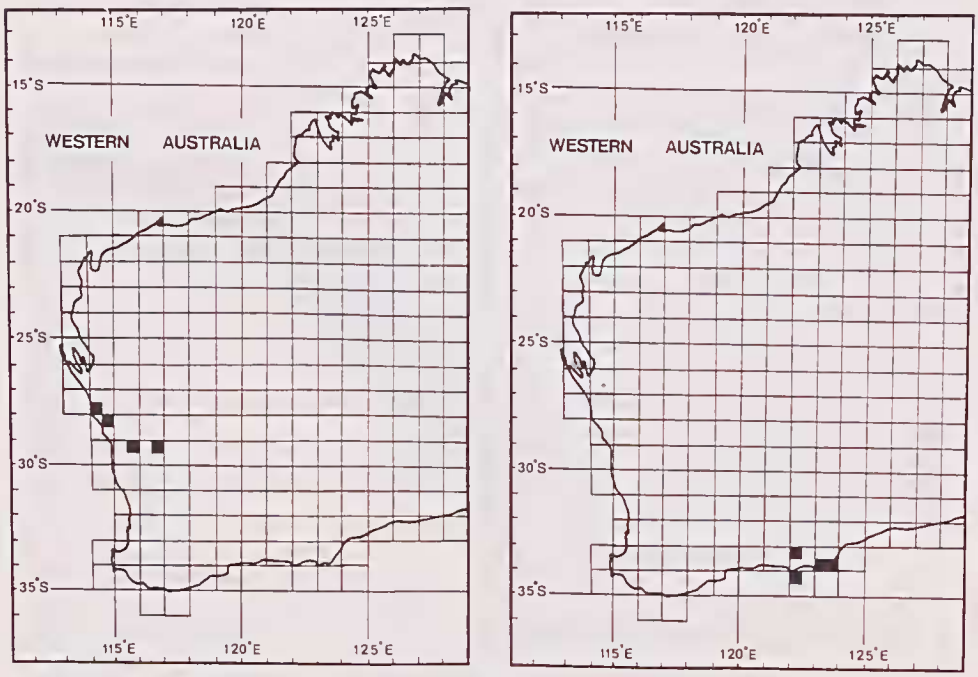

Figure 25. Distributions of **a**, *Persoonia hexagona* and **b**, *Persoonia spathulata*.

distinguished from *P. scabra* by its incurved-patent branchlet indumentum and its strongly scabrous leaves. *P. spathulata* was not collected between 1802 and 1979, presumably because of its patchy distribution in a relatively poorly collected area.

Specimens examined: Roe: 15 km N of Mt Ridley, 33° 10' S, 122° 08' E, *W.R. Archer 1307914*, Jul 1991 (NSW); 14.5 km N of Mt Ridley, 33° 09' 30" S, 122° 08' 00" E, *W.R. Archer 712913*, Dec 1991 (NSW, CBG, K, MEL, PERTH). Eyre: 12 km SW of Israelite Bay, 33° 41' S, 123° 46' E, *B. Barnsley 365*, Jan 1979 (CBG); 44 km SW of Mt Ragged, 33° 43' S, 123° 06' E, *K. Newbey 6802*, May 1980 (PERTH).

26. Persoonia scabra *R. Br.*

(Brown 1810a: 162, 1810b: 373); Sprengel (1825: 473); Meisner (1856: 337); Bentham (1870: 389).

Linkia scabra (R. Br). Kuntze (Kuntze 1891: 579)

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: in collibus saxosis. (ubi v.v.)'

Holotype: a specimen labelled 'No. 3281. R. Brown Bay I South Coast'; annotated by Brown (BM, photo NSW).

Erect, spreading shrub with many stems branching from below ground level, 0.3–0.9 m high, regenerating after disturbance from lignotuber; underground parts not known. *Bark* smooth, compact, grey. *Hairs* of medium length, antrorsely spreading, greyish or whitish. *Branchlets* terete, moderately to densely hairy when young but glabrescent after 3 or 4 years. *Leaves* alternate, narrowly oblong to oblanceolate or occasionally narrowly spathulate, symmetrical to slightly asymmetrical, usually twisted at base so that lamina is held in ± vertical plane, flat, acuminate to mucronate, often pungent, (0.5–)1.5–3.5 cm long, 2.5–6 mm wide, usually crowded at end of season's growth and sometimes on short lateral branchlets, mostly suberect to erect, sometimes slightly incurved, leathery and rigid, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation acrodromous to brochidodromous; midvein evident to prominent on both surfaces; marginal veins absent; intramarginal and other veins obscure to evident on both surfaces; epidermis sparsely papillose and scaberulous. *Scale leaves* triangular, acute, 0.8–2.5 mm long, 0.4–0.8 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or anauxotelic, basitonic or pantotonic, 1–3-flowered; rachis to 0.5 cm long. *Flowers* usually subtended by scale leaves but occasionally by reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 1.5–4.5 mm long, not consistently longer at base of inflorescence than at tip, glabrous or moderately hairy. *Tepals* ± narrow-oblong to lanceolate, sometimes constricted below anthers, acute to obtuse, 6.5–10 mm long, 1.5–2 mm wide, yellow, glabrous or moderately hairy on outside, glabrous on inside except for marginal patches of papillae just below anthers; lateral flaps to 0.2 mm wide. *Filaments* adnate to tepals, 1.5–2 mm long, 1/5–1/4 as long as tepals. *Anthers* yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but reflexed through 90°–180° at appendage, adnate to tepals for lower 1/6–1/3 of loculi; connective as wide as or slightly wider than loculi; loculi glabrous, 3–3.5 mm long; appendage ± oblong, 1.5–2 mm long, 1/2–2/3 as long as loculi. *Gynoecium* about as long as stamens, exserted, 6–8 mm long, glabrous; ovary slightly contracted at base, no thicker than base of style; style straight, with 8 obscure to conspicuous longitudinal ridges, capitate but otherwise ± constant in thickness or tapering slightly from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with stipe, in line with style; pyrene ellipsoid to obovoid, 8–9.5 mm long, 4.5–5 mm wide, smooth; seed 1; embryo straight; cotyledons 5–6.

Habitat: In white sand or sandy loam, in very open shrub mallee; locally common.

Flowering period: November to January.

Distribution: (Fig. 26a) Roe and Eyre districts: an area roughly bounded by Frank Hann National Park, Mt Buraminya and Cape Le Grand.

Conservation status: Not rare (coded 3RC- by Briggs & Leigh 1988, on the basis of the few collections that had been identified at that time).

Variation: Leaf shape varies considerably in *P. scabra* but the variation seems to be as great within single populations as between them. The type specimen has moderately hairy pedicels and tepals while in the three other flower-bearing specimens, the pedicels and tepals are glabrous. It is unclear whether this difference is taxonomically significant, given the small number of fertile specimens.

Discussion: This species most closely resembles *P. spathulata* but is distinguished from that species as outlined above. It is distinguished from all other species by the following combination of characters: leaves pungent, scaberulous, lacking prominently protruding secondary veins, (0.5–)1.5–3.5 mm long, 2.5–6 mm wide; flowers regular; anther appendages present, reflexed through 90°–180°. *P. scabra* was not collected between 1802 and 1978, presumably because of its distribution in poorly collected country.

Selected specimens (11 examined): Roe: 33.2 km SW of 90 mile tank on Hanns Track, 32° 52' S, 120° 25' E, *P.H. Weston 248*, Dec 1980 (SYD, NSW, PERTH); 72 km W of Salmon Gums, *K. Newbey 6473*, Nov 1979 (PERTH); 5.5 km SE of Mt Ridley, 33° 20' 00" S, 122° 08' 30" E, *W.R. Archer 712916*, Dec 1991 (NSW, CBG, K, MEL, MO, PERTH); 12 km SW of Mt Buraminya, 33° 20' S, 123° 04' E, *K. Newbey 8207*, Nov 1980 (PERTH). Eyre: Thistle Cove, 34° 00' S, 122° 12' E, *A. Strid 21916*, Jan 1983 (NSW).

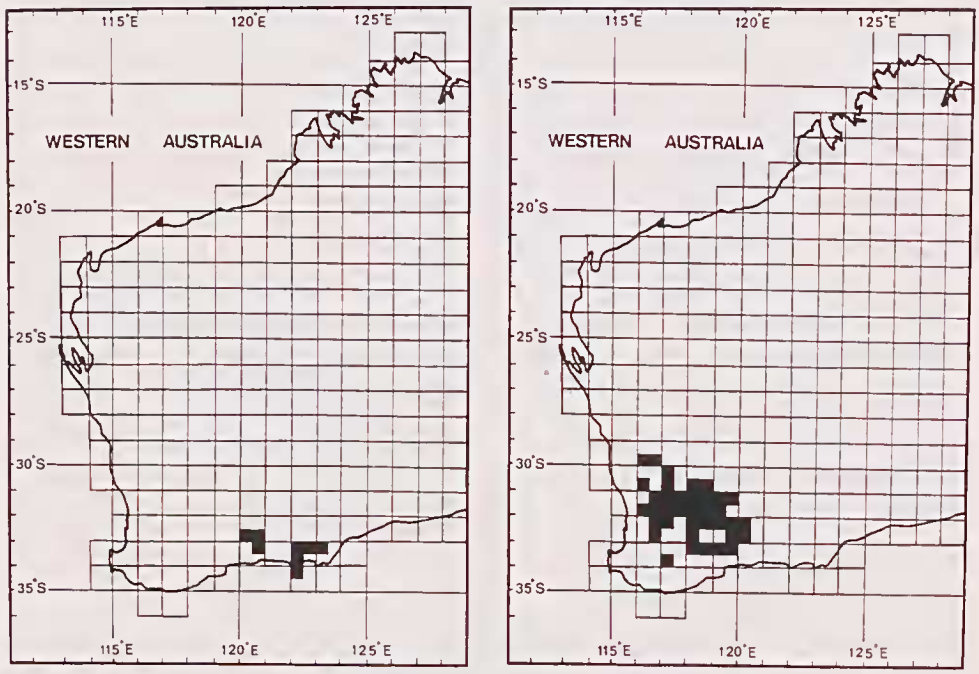

Figure 26. Distributions of a, *Persoonia scabra* and b, *Persoonia quinquenervis*.

27. Persoonia quinquenervis *Hook.*

(Hooker 1842: 425); Meisner (1845: 532, 1856: 332); Bentham (1870: 389).

Linkia quinquenervis (Hook.) Kuntze (Kuntze 1891: 579).

Type citation: 'N. Holland, Swan River Colony. Mr James Drummond.'

Lectotype (here designated): A sheet labelled 'Swan River. N Holland. Drummond' and stamped 'Herbarium Hookerianum 1867' (K, photo NSW). The specimen on the right-hand side of the sheet is designated lectotype. Isolectotypes?: E, FI.

P. striolata Kippist (Kippist in Meisner 1855: 72, 1856: 332). Type citation: 'Drummond, coll. v. Suppl. n.6'. Syntypes: BM, CGE, FI, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL.

Barker & Barker (1990) argue that Meisner did not see material of *P. striolata* but coined the name to accompany a description supplied by Kippist, published in Meisner (1855). As one might expect, I could not find type material in Meisner's herbarium at NY.

Erect, spreading shrub, usually with several to many stems branching from base, 0.2–2.5 m high, regenerating after disturbance from lignotuber, sometimes with spreading but not very extensive underground rhizome which lies c. 5 cm below soil surface and from which aerial stems arise at irregular intervals; root system not known. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish or whitish. *Branchlets* often angular when immature and remaining so when mature but becoming terete within 2 years, sparsely to densely hairy when young but glabrescent with age. *Leaves* alternate, oblanceolate or narrow-spathulate or narrow-elliptical or narrow-oblong or linear, usually symmetrical, twisted at base so that most of laminae are held in ± vertical plane or twisted through 1/4–1 1/2 complete turns, flat to flattened or ± compressed and usually with 3–13 longitudinal ridges on both surfaces or subterete with 8 longitudinal ridges, acute or acuminate or obtuse or mucronate, not pungent, (0.5–)2–7.5 cm long, 0.8–10 mm wide, often crowded at end of season's growth or on short lateral branchlets, mostly suberect to erect, often curved upwards slightly, leathery and rigid to flexible, often glaucous, concolorous, glabrous to moderately hairy when immature, glabrescent when mature; venation acrodromous to parallelodromous; midvein evident to prominent on both surfaces; marginal veins prominent; intramarginal and often other pairs of veins evident to prominent on both surfaces; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular to narrow-triangular or narrow-oblong, acute, 1–5 mm long, 0.5–1 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic, 1–10-flowered; rachis to 6 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 4–17 mm long, not consistently longer at base of inflorescence than at tip, sparsely to moderately hairy. *Tepals* ± narrow-oblong to ± oblanceolate, truncate at base, often constricted below anthers, acuminate to mucronate, 7.5–15 mm long, 1.5–2.5 mm wide, bright yellow, glabrous to sparsely hairy on outside, glabrous on inside except for marginal rows or patches of papillae on proximal 1/2; lateral flaps to 0.5 mm wide. *Filaments* adnate to tepals, 2.3–4 mm long, 1/5–1/3 as long as tepals. *Anthers* bright yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but reflexed at appendage to almost 90°, adnate to tepals for about lower 1/6–1/2 of loculi; connective as wide as or slightly wider than loculi; loculi glabrous, 2.7–5.5 mm long; appendage ± oblong to ± triangular, 0.4–1 mm long, 1/4–1/9 as long as loculi. *Gynoecium* longer than stamens, exserted, 6.5–11.5 mm long, glabrous; ovary slightly contracted at base, no thicker or slightly

thicker than base of style; style straight, with 8 conspicuous longitudinal ridges, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to obovoid, smooth; long axis in line with stipe, in line with style; pyrene ellipsoid to obovoid, 8–12 mm long, 4–6 mm wide, smooth; seed 1; embryo straight; cotyledons 5–8.

Habitat: Usually on sand to loam, often over laterite or gravel, in heath, mallee-heath, *Acacia/Allocasuarina/Eucalyptus* thicket or in *Eucalyptus* woodland or dry sclerophyll forest; common throughout its distribution.

Flowering period: Usually November to December but occasionally as early as July.

Distribution: (Fig. 26b) South-western Australia: an area roughly bounded by Latham, Boyagin Nature Reserve, Tarin Rock, Frank Hann National Park and Yellowdine.

Conservation status: Not rare.

Variation: This species exhibits spectacular variation in leaf morphology and anatomy which is geographically correlated apart from the exceptions noted below. Other characters such as flower size and pedicel length show minor between-specimen variation but this does not seem to be correlated with distribution. The extreme geographical variants may be characterised as follows. Western form (York area): leaves twisted through about 1/4 of a turn, narrow-spathulate to oblanceolate, (1–)2.5–5.5 cm long, 3–10 mm wide, flat with 5–13 prominent parallel ridges on both surfaces (formed by the protruding midvein and secondary veins; tertiary veins evident) sometimes slightly glaucous. Northern form (Bunjil - Buntine area): leaves twisted through 1/4–1 turn, linear, (0.5–)2.5–7 cm long, 2–3 mm wide, flat with 5 or occasionally 3 or 7 evident parallel ridges on both surfaces (tertiary veins obscure), sometimes glaucous. Southern form (Lake Grace - Lake King area): leaves twisted through 1/4 to 1 turn, narrow-spathulate, (0.7–)2–4.5 mm long, 3–7.5 mm wide, flat with 5 or 7 prominent ridges on both surfaces (tertiary veins evident), glaucous. Eastern form (Merredin – Narembeen – Hyden – Johnston Lakes – Yellowdine area): leaves twisted through 1/2–1 1/2 turns, linear, (0.8–)3–7.5 cm long, 0.8–1.6 mm wide, subterete with 8 prominent parallel ridges or dorsiventrally compressed with 3 prominent ridges on both surfaces (tertiary veins obscure), often glaucous. Clinal variation links these extremes in the intervening areas. However, two specimens at PERTH, *Muir 110* (Billyacatting Hill Reserve) and *W.E. Blackall s.n. Sep 1929* (between Bruce Rock and Merredin), which are typical extreme western forms in morphology, were collected at localities within the range of the typical extreme eastern forms. Several explanations for this anomaly seem reasonable: (a) the specimens were erroneously labelled, (b) two sibling species are involved, some forms of which cannot be diagnosed from one another, or (c) leaf morphology is phenotypically plastic, and variation in leaf morphology simply reflects geographic variation in habitat types. Explanation (c) seems weak considering the relative lack of variability within individuals. Explanations (a) and (b) could be tested easily by searching the collection localities of the anomalous specimens. Absence of anomalous plants would support explanation (a), while presence of anomalous plants growing alongside typical 'eastern' individuals would support explanation (b). Presence of anomalous plants and absence of 'eastern' plants would be inconclusive. Explanation (c) could be tested by growing plants collected from different localities under constant environmental conditions (i.e. conducting a growth experiment).

Discussion: Because of its variability, this species has been confused with several others, most notably *P. striata*, but also with *P. sulcata*, *P. coriacea* and *P. saundersiana*. It is distinguished easily from *P. saundersiana* by its regular flowers with yellow anthers and from *P. coriacea* by its anthers possessing appendages and its (usually) prominent midvein and secondary veins. From *P. sulcata* it differs in having non-

pungent leaves and shorter, less recurved anther appendages. *P. striata* most closely resembles the narrow-leaved forms of *P. quinquenervis* but is distinguished from them by its longer, more recurved anther appendages as well as by leaf anatomical characters (in *P. quinquenervis* the marginal veins are the only ones that reach the epidermis whereas in *P. striata*, fibre bundles associated with the midvein and intramarginal veins also reach the epidermis). Populations of both these species grow sympatrically at some localities (e.g. *P.H. Weston 255, 256*; SYD) and do not hybridise. *P. quinquenervis* is distinguished from all other species by a combination of the above-mentioned characters and its glabrous gynoecium.

Selected specimens (110 examined): Darling: between Mogumber and Gillingarra, *W.V. Fitzgerald s.n.*, Nov 1903 (NSW); 15 km W of York, 31°54' S, 116°39' E, *P.H. Weston 151*, Nov 1980 (SYD). Avon: 3 miles [5 km] S of Latham, *J.S. Beard 7376*, Nov 1974 (PERTH); Manmanning rubbish tip, 30°51' S, 117°05' E, *P.H. Weston 325*, Dec 1980 (SYD); Merredin, *M. Koch 2720*, Nov 1923 (NSW); 15 miles [24 km] S of Tammin, *R.D. Royce 9333*, Nov 1970 (PERTH); Narembeen, *W.E. Blackall s.n.*, Sep 1929 (PERTH); Boyagin Reserve, 32°30' S, 116°50' E, *H. Demarz 1381*, Aug 1969 (KPBG). Coolgardie: 3.9 km W of Yellowdine, 31°18' S, 119°36' E, *P.H. Weston 141*, Nov 1980 (SYD). Roe: 0.3 km SE of Hatters Hill, *K. Newbey 5453*, Aug 1979 (PERTH); c. 14 km SE of Kulin, 32°43' S, 118°16' E, *R. Hnatiuk 770162*, Jul 1977 (PERTH); Lake Camm turn-off E of Newdegate, *A.S. George 2266*, Dec 1960 (PERTH).

28. Persoonia striata *R. Br.*

(Brown 1830: 13); Meisner (1856: 332); Bentham (1870: 388).

Linkia striata (R. Br.) Kuntze (Kuntze 1891: 579).

Type citation: 'Ora occid.-merid., King George's Sound,1829. D. Baxter.'

Lectotype (here designated): On a sheet labelled 'West coast of New Holland 1828-29 Mr William Baxter rec^{d} April 1830'; annotated by Brown (BM photo NSW). Four specimens are mounted on this sheet. The specimen in the lower right-hand corner is designated lectotype. The specimen in the upper left-hand corner is labelled 'South-west Australia George Maxwell Near W. M. Barren' and is not part of the type material.

Erect, often spreading shrub, with single main stem or with several branching from base or from underground, 0.15–0.7 m high, regenerating after disturbance from lignotuber, usually with spreading but not very extensive underground rhizome which lies about 5 cm below soil surface and from which aerial stems arise at irregular intervals; root system not known. *Bark* smooth, compact, mottled grey. *Hairs* of medium length, appressed to antrorsely spreading, greyish or whitish. *Branchlets* sometimes slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear-spathulate to linear-oblong, symmetrical to slightly asymmetrical, usually not twisted, flat or dorsiventrally flattened or compressed or rarely dorsally plano-convex but usually with 3 longitudinal ridges on both surfaces, acuminate to mucronate, not pungent, (0.5–)1–4.5 cm long, 0.7–2.7 mm wide, often crowded, mostly suberect to erect, often curved upwards slightly, leathery and flexible to rigid, not glaucous, concolorous, sparsely hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent or rarely evident on both surfaces; marginal veins evident to prominent; intramarginal veins prominent or rarely evident on both surfaces; other veins obscure; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 0.5–2 mm long, 0.3–0.5 mm wide. *Inflorescences* terminal or subterminal or axillary, mostly auxotelic, basitonic, 1–5-flowered; rachis to 0.2 cm long. *Flowers* subtended by scale leaves or very rarely reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 2.5–9

mm long, not consistently longer at base of inflorescence than at tip, glabrous to sparsely hairy. *Tepals* ± narrow-elliptical to ± oblanceolate, truncate at base, often slightly constricted below anthers, acute to acuminate, 8.5–12.5 mm long, 1.5–2 mm wide, bright yellow, glabrous; lateral flaps to 0.3 mm wide. *Filaments* adnate to tepals, 1.8–3.2 mm long, 1/5–3/10 as long as tepals. *Anthers* bright yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 90°–180° at appendage, adnate to tepals for lower 1/7–1/2 of loculi; connective as wide as or slightly wider than loculi; loculi glabrous, 3–5.5 mm long; appendage ± oblong, 1.4–2.8 mm long, 1/3–4/5 as long as loculi. *Gynoecium* longer than stamens, exserted, 6.5–10.5 mm long, glabrous; ovary not contracted at base, no thicker than base of style; style straight, with 8 conspicuous longitudinal ridges on lower half, capitate but otherwise tapering slightly from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with stipe, in line with style; pyrene ellipsoid to obovoid, 8–9.5 mm long, 4–4.5 mm wide, smooth; seed 1; embryo straight; cotyledons not known.

Habitat: In sand or loam to clay, often over laterite or gravel, usually in low heath or mallee-heath; often locally common.

Flowering period: November to December.

Distribution: (Fig. 27a) Roe and Eyre districts: an area roughly bounded by Lake Hope, Dumbleyung, Albany.

Conservation status: Not rare.

Variation: Minor differences in leaf morphology, flower size and the relative lengths of anther loculi to anther appendages and filaments to tepals are found within and between populations. This variation does not appear to be geographically correlated.

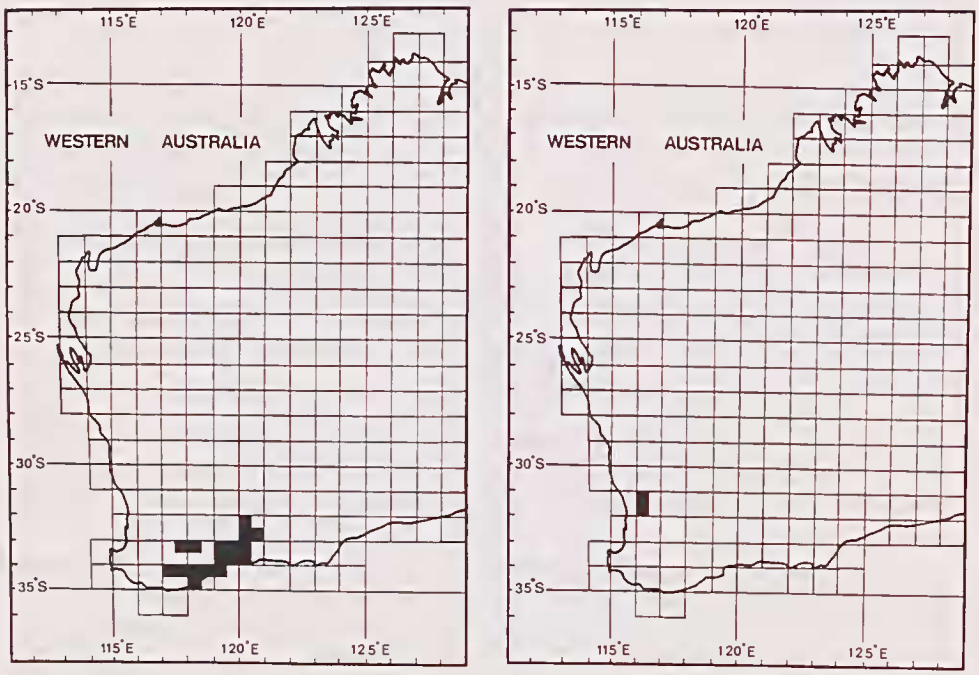

Figure 27. Distributions of **a**, *Persoonia striata* and **b**, *Persoonia sulcata*.

Discussion: *P. striata* is distinguished from all other species by the following combination of characters: leaves linear to linear-spathulate, not pungent, with 3 prominent longitudinal ridges on both surfaces; flowers regular; anther appendages reflexed through 90°–180°, 1.4–2.8 mm long, 1/3–4/5 as long as the loculi, gynoecium glabrous. It most closely resembles the narrow-leaved forms of *P. quinquenervis* but is distinguished from them by the abovementioned anther character as well as leaf characters noted in the discussion of that species.

Selected specimens (33 examined): Avon: near Dumbleyung, *W.E. Blackall 1342*, Nov 1931 (PERTH). Roe: 39.5 km E of Southern Cross-Lake King road on Hyden-Norseman road, 32° 18' S, 120° 09' E; *P.H. Weston 342*, Dec 1980 (SYD); Frank Hann National Park, 32° 49' S, 120° 30' E, *K. Newbey 6847*, Aug 1980 (PERTH); 13.6 km W of Lake Grace, 33° 06' S, 118° 20' E, *P.H. Weston 256*, Dec 1980 (SYD, PERTH); 11 miles [18 km] from Lake King towards Newdegate, *J.W. Wrigley s.n.*, Nov 1965 (CBG, PERTH). Eyre: Kundip, *C.A. Gardner 2942*, Nov 1931 (PERTH); below Mt Bland near W Mt Barren, *R. Coveny 3322*, *T.E.H. Aplin & I. Lethbridge*, Sep 1970 (NSW); N slopes of Stirling Range on Salt Lake [Salt River] Rd., *E.C. Nelson s.n.*, Sep 1973 (CANB, PERTH).

29. Persoonia sulcata *Meisn.*

[Meisner (1852: 185) nom. nud.] (Meisner 1856: 333); Bentham (1870: 387).

Linkia sulcata (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'In colonia Swan River (Drumm. coll. 4, n 274!)'

Lectotype (here designated): A sheet labelled by Meisner *'Persoonia sulcata nob* (19 Jan. 1850). Swan River Drummond, coll. 1848, n. 274! Comm. am. Shuttleworth 1849' (NY). Isolectotypes: BM, CGE, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, PERTH, TCD.

Erect, spreading to decumbent shrub, with several to many stems branching near base, 0.2–1 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, grey. *Hairs* short to medium length, appressed to antrorsely spreading, greyish. *Branchlets* sometimes slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, twisted to 1/4 of complete turn, dorsally plano-convex to concave with 6 longitudinal ridges, acuminate, pungent, (0.5–)1.5–5 cm long, 0.9–1.2 mm wide, often crowded, mostly patent to suberect, not usually curved in dorsiventral plane, leathery and rigid, not glaucous, concolorous or ridges paler in colour than rest of lamina, sparsely to moderately hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth. *Scale leaves* triangular to narrow-triangular, acute, 0.4–2 mm long, 0.2–0.4 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or anauxotelic, basitonic, 1–3-flowered; rachis to 0.1 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 3–12 mm long, not consistently longer at base of inflorescence than at tip, glabrous. *Tepals* ± narrow-elliptical to ± lanceolate, truncate at base, often slightly constricted below anthers, acute to acuminate, 8–11 mm long, 1.2–1.8 mm wide, yellow, glabrous; lateral flaps absent. *Filaments* adnate to tepals, 1.5–2.5 mm long, 1/6–1/4 as long as tepals. *Anthers* yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 180° at appendage, adnate to tepals for lower 1/4–3/5 of loculi; connective about as wide as loculi; loculi glabrous, 2.8–3.6 mm long; appendage ± oblong to ± triangular, 1.5–2.2 mm long, 1/2–3/5 as long as loculi. *Gynoecium* longer than stamens, exserted, 6.5–8.5 mm long, glabrous; ovary not contracted at

base, no thicker or slightly thicker than base of style; style ± straight but often recurved at tip, with 8 obscure to prominent longitudinal ridges, tapering slightly from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to obovoid, smooth; long axis in line with stipe, in line with style; pyrene obovoid, 7–8 mm long, 5–5.5 mm wide, smooth; seed 1; embryo straight; cotyledons not known.

Habitat: In laterite in *Eucalyptus* woodland or on rocky granite slopes; in small populations.

Flowering period: September to November.

Distribution: (Fig. 27b) Darling district: disjunctly distributed in the New Norcia – Calingiri – Mogumber area and at John Forrest National Park.

Conservation status: 2VCi (Briggs & Leigh 1988).

Variation: *P. sulcata* exhibits geographic variation in leaf and pedicel length. The northern populations may be characterised as follows: leaves (0.5–)1.5–4 cm long; pedicels 2.5–8 mm long. Within the northern group of populations, leaf length and flower size vary only slightly between specimens. The two specimens from John Forrest National Park have leaves 2.5–5 cm long and pedicels 7–12 mm long.

Discussion: *P. sulcata* is distinguished by the following combination of characters: leaves linear, pungent, (0.5–)1–5 cm long, 0.9–1.2 mm wide, dorsally plano-convex to concave, with 6 longitudinal ridges, not glaucous; flowers regular; anther appendage ± oblong to ± triangular, reflexed through 180°. It most closely resembles *P. striata* and *P. acicularis* and is distinguished from the former by its pungent leaves and from the latter by its leaf cross-sectional shape and shape of anther appendage.

Specimens examined: Darling: Mogumber, *W.V. Fitzgerald s.n.*, Oct 1903 (PERTH); Mogumber, *A. Morrison s.n.*, Nov 1906 (CANB, PERTH); 5 miles [8 km] W of Calingiri, *R.D. Royce 5653*, Oct 1956 (PERTH); 7 miles [11 km] E of Wannamal, *A.S. George 5942*, Nov 1963 (PERTH); S of New Norcia, *A.M. Ashby 1335*, Nov 1964 (AD), 65 mile peg on Geraldton road, *D.H. Perry s.n.*, Sep 1948 (PERTH); 63-4 mile pegs Great Northern Highway, *A.S. George 11700*, Sep 1973 (PERTH); Great Northern Highway, 12.4 km N of Toodyay turn-off, 31° 13' S, 116° 11' E, *P.H. Weston 326*, Dec 1980 (SYD, PERTH); near Bindoon, *D. Lewis s.n.*, Aug 1964 (NSW); John Forrest National Park, *P.G. Armstrong 30/8 & 30/10*, Aug & Oct 1985 (PERTH).

30. Persoonia acicularis *F. Muell.*

(Mueller 1868: 220); Bentham (1870: 388).

Linkia acicularis (F. Muell.) Kuntze (Kuntze 1891: 579).

Type citation: 'In planitiebus arenosis ad fluvium Murchisoni. Oldf.'

Lectotype (here designated): a sheet labelled 'Persoonia acicularis Ferd. von Mueller. Murchison R. W.A. Oldf.' (MEL 103668, photo NSW). Isolectotypes: K (photo NSW), NSW, PERTH (n.v.).

Erect shrub with single main stem or with several main stems close together, 0.1–1.2 m high, regenerating after disturbance from lignotuber, with extensive linear stolon-like rhizomes which lie about 5 cm below soil surface and from which aerial stems arise at irregular intervals; root system not known. *Bark* smooth but sometimes fissured and excorticating at base, compact, grey. *Hairs* short to medium length, antrorsely spreading or patent or curly, greyish. *Branchlets* sometimes slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, twisted

to 1 complete turn, dorsiventrally compressed to subterete with 4 or 6 narrow longitudinal grooves, acuminate, pungent, (0.5–)1.2–2.5 cm long, 0.6–1 mm wide, often crowded, mostly patent to suberect, not curved in dorsiventral plane, leathery and rigid, glaucous, concolorous, glabrous to moderately hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins absent or prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 0.4–2.5 mm long, 0.1–0.6 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic or anauxotelic, basitonic, 1–80-flowered; rachis to 12 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to horizontally but sometimes pendulous depending on orientation of inflorescence. *Pedicels* 3–10 mm long, not consistently longer at base of inflorescence than at tip, glabrous to sparsely hairy. *Tepals* ± narrow-oblong to ± lanceolate, truncate at base, constricted below anthers, acuminate, 8.5–15.5 mm long, 1.5–2 mm wide, bright yellow, glabrous on outside, glabrous on inside except for marginal rows of papillae on proximal 1/3; lateral flaps to 0.4 mm wide. *Filaments* adnate to tepals, 2–5 mm long, 1/3–1/4 as long as tepals. *Anthers* bright yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but slightly reflexed at appendage, adnate to tepals for about lower 2/3–1/6 of loculi; connective narrower than or as wide as loculi; loculi glabrous, 3.5–5 mm long; appendage ± globular or slightly elongated, 0.3–0.6 mm long, 1/10–1/15 as long as loculi. *Gynoecium* longer than stamens, exserted, 7.5–12.5 mm long, glabrous; ovary slightly contracted at base, no thicker to slightly thicker than base of style; style straight, with 8 obscure to prominent longitudinal ridges, capitate but otherwise tapering slightly from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene ellipsoid to obovoid, 8–10.5 mm long, 3.5–5 mm wide, smooth; seed 1; embryo straight; cotyledons 6.

Habitat: In acid yellow or brown sand or sandy loam, often over laterite or on red calcareous sand, in low heath or mallee-heath; locally common.

Flowering period: August to January.

Distribution: (Fig. 28a) Irwin district: three apparently disjunct areas at Shark Bay, Kalbarri National Park and Arrowsmith River.

Conservation status: Not rare.

Variation: *P. acicularis* shows geographically correlated variation in leaf morphology and anatomy. Specimens collected south of Geraldton in the Arrowsmith River area have 6-ribbed leaves while those north of Geraldton have 4-ribbed leaves, lacking a pair of intramarginal veins. In general, the more southern populations have longer, more erect leaves than do the northern populations although exceptions to this trend may be found in all areas. There is considerable variation in flower size but this does not seem to be geographically correlated.

Discussion: *P. acicularis* is a distinctive species distinguished by the following combination of characters: leaves linear, pungent, (0.5–)1.2–2.5 cm long, 0.6–1 mm wide, dorsiventrally compressed to subterete with 4 or 6 narrow longitudinal grooves, glaucous; flowers regular; anther appendages ± globular or slightly elongated. It has been misidentified frequently as *P. sulcata* but differs from that species in leaf cross-sectional shape, in its glaucous leaves and in shape of anther appendage.

Selected specimens (22 examined): Irwin: 12 miles [19 km] W of Hamelin homestead, *T.J. Hawkeswood s.n.*, Apr 1979 (PERTH); Tamala station, *H. Demarz 6125*, Aug 1976 (PERTH); Mary

Springs station, 27° 45' S, 114° 40' E, *H. Demarz 3465*, Oct 1971 (PERTH); Junga Dam, Kalbarri National Park, 27° 45' S, 114° 21' E, *P.H. Weston 294*, Dec 1980 (SYD); Wittecarra Gully, 8 km SSE of Kalbarri, *P.G. Wilson 6602*, May 1968 (PERTH); E margin of Kalbarri National Park, 27° 54' S, 114° 35' E, *R. Pullen 9644*, Nov 1974 (CANB); N of Arrowsmith River on Dongara road, *A.M. Ashby 3238*, Jun 1970 (AD), Skipper Rd. 5.0 km E of Brand Highway, 29° 38' S, 115° 16' E, *P.H. Weston 301*, Dec 1980 (SYD).

31. Persoonia rudis *Meisn.*

[Meisner (1852: 185) nom. nud.] (Meisner 1856: 333); Bentham (1870: 387).

Linkia rudis (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'In colonia Swan River (Drumm. 4, n.273!)'

Lectotype (here designated): a sheet labelled by Meisner '*Persoonia rudis* nob. Swan River legit. Drummond, n. 273! Shuttl. 11.Oct.1853.' (NY). Isolectotypes: BM, CGE, FI, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, NSW, PERTH, TCD.

Erect, often spreading shrub with several to many stems branching from below ground level, 0.2–1 m high; means of regeneration, underground parts not known. *Bark* not known. *Hairs* of medium length to long, antrorsely spreading to patent, pale brown or greyish. *Branchlets* sometimes angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, sometimes slightly asymmetrical, not twisted, dorsally plano-convex to deeply concave, acuminate, sharp but not pungent, (0.5–)1.5–4.5 cm long, 0.7–1.4 mm wide, usually crowded, mostly suberect to erect, usually curved upwards slightly, leathery and rigid to rather flexible, not glaucous, concolorous, moderately to densely hairy when immature, glabrescent or retaining sparse to moderate cover of hairs when mature; venation hyphodromous or parallelodromous; midvein obscure or evident on abaxial surface; marginal veins absent; intramarginal

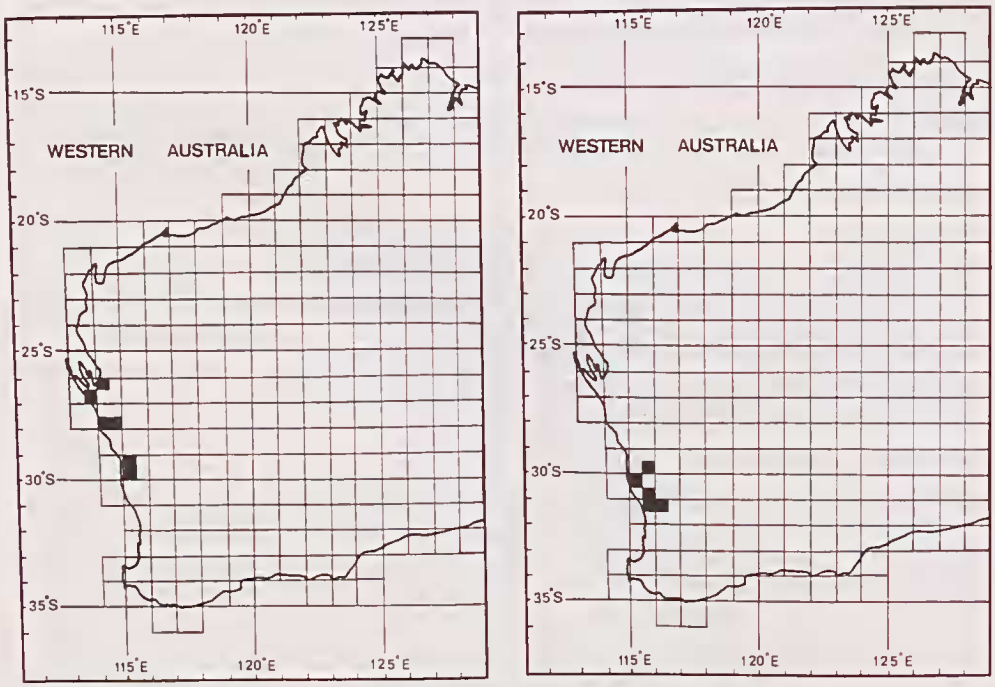

Figure 28. Distributions of a, *Persoonia acicularis* and b, *Persoonia rudis*.

veins obscure or evident on abaxial surface; other veins obscure; epidermis papillose and scabrous. *Scale leaves* narrow-triangular, acute to acuminate, 0.7–5 mm long, 0.2–0.6 mm wide. *Inflorescences* terminal or subterminal, auxotelic, basitonic, (1–)5–30-flowered; rachis (0–)0.3–10 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 2–10 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* ± narrow-oblong to ± oblanceolate, truncate at base, occasionally slightly constricted below anthers, acuminate, 8–14 mm long, 1–2 mm wide, yellow, moderately hairy on outside, glabrous on inside or with marginal rows of papillae below anthers; lateral flaps to 0.2 mm wide. *Filaments* adnate to tepals, 2.5–4 mm long, 1/5–3/10 as long as tepals. *Anthers* yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 180° at appendage, adnate to tepals for about lower 1/4–1/3 of loculi; connective prominently wider than loculi; loculi glabrous, 3–5.5 mm long; appendage ± oblong, 1.5–3 mm long, 1/3–3/5 as long as loculi. *Gynoecium* about as long as stamens, exserted, 6.5–12.5 mm long; ovary densely covered in antrorsely spreading pale brown to greyish hairs, basally contracted into distinct stipe, conspicuously thicker than base of style; style densely hairy or upper half glabrous, straight, not ridged, capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth, moderately hairy; long axis in line with stipe, in line with style; pyrene ellipsoid, 8.5–9 mm long, 5.5–6 mm wide, smooth; seed 1; embryo straight; cotyledons 8–9.

Habitat: In yellow sand, often over laterite, in low heath or *Eucalyptus calophylla* forest; apparently in small populations or occurring as isolated individuals.

Flowering period: October to January.

Distribution: (Fig. 28b) Irwin and Darling districts: Three Springs south to Mogumber.

Conservation status: 3E (Briggs & Leigh 1988).

Variation: There is some variation in flower size and hair density on shoots and tepals but it does not appear to geographically correlated.

Discussion: *P. rudis* is a distinctive species that may be recognised easily by the long, mostly patent hairs on the young shoots or by the combination of non-pungent leaves, which are not prominently ribbed, and the exserted gynoecium with a densely hairy ovary. It most closely resembles *P. filiformis* with which it is sympatric but differs from it in the above characters and also in its oblong anther appendage.

Selected specimens (13 examined): Irwin: 10 miles [16 km] W of Three Springs, J.S. Beard 7257, Nov 1974 (PERTH); W of Mt Peron, c. 30° 06' S, 115° 07' E, *A.S. George 11196*, Nov 1971 (PERTH, SYD). Darling: Jurien Bay, *R.D. Royce 7720*, Nov 1962 (PERTH); 16 km E of Jurien, 30° 19' S, 115° 12' E, *A. Strid 21685*, Dec 1982 (NSW); 0.8 km S of Mogumber turn-off, Brand Hwy, 31° 00' S, 115° 42' E, *A.S. George 16307*, Oct 1984 (PERTH).

32. Persoonia filiformis *P.H. Weston*, **sp. nov.**

Folia linearia, pungentia, (0.5–)1–2 cm longa, 0.7–1 mm lata. Flores regulares. Gynoecium exsertum, glabrum, stamina aequans vel superans. Tepala extus glabra. Appendix antherae ad basim plusminusve triangularis sed apice filiformi et saepe sinuata.

Holotype: Western Australia: Irwin: About 0.5 km east of Jurien Bay turnoff from Brand Hwy., 30° 13' S, 115° 25' E, *P.H. Weston 277*, 11 Dec 1980 (SYD). Isotype: PERTH.

Erect, spreading shrub with several to many stems branching from below ground level, 0.07–0.4 m high, regenerating after disturbance from lignotuber, without spread-

ing or extensive underground stems and with thickened taproot. *Bark* thin. *Hairs* of medium length, antrorsely spreading to patent, greyish or whitish. *Branchlets* sometimes angular when immature but becoming terete when mature, moderately hairy when young but glabrescent with age. *Leaves* alternate, linear, usually symmetrical, not usually twisted, dorsally plano-convex to concave, acuminate, pungent, (0.5–)1–2 cm long, 0.7–1 mm wide, usually crowded, mostly suberect to erect, not usually curved in dorsiventral plane, leathery and rigid, usually slightly glaucous, concolorous, glabrous to moderately hairy when immature, glabrescent when mature; venation parallelodromous; midvein prominent on both surfaces; marginal veins prominent; intramarginal veins prominent on abaxial surface, obscure on adaxial surface; other veins obscure; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 0.9–1.3 mm long, 0.2–0.3 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic, basitonic, 1–20-flowered; rachis to 3 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, regular, mostly held upright to subupright. *Pedicels* 1–2 mm long, not consistently longer at base of inflorescence than at tip, glabrous. *Tepals* ± narrow-oblong to ± lanceolate but attenuate at tip, truncate at base, not constricted below anthers, acuminate, 11–16 mm long, 1.4–2 mm wide, greenish yellow, glabrous on outside, glabrous on inside except for marginal patches or rows of papillae below anthers; lateral flaps 0.3–0.6 mm wide. *Filaments* adnate to tepals, 2.7–3.5 mm long, 1/4–1/5 as long as tepals. *Anthers* greenish yellow, introrse, held close together and close to gynoecium from their bases to tips of loculi, ± straight but abruptly reflexed through 90°–180° at appendage, adnate to tepals for lower 1/2–1/10 of loculi; connective wider than loculi; loculi glabrous, 3.5–5.6 mm long; appendage ± triangular at base but narrowing to filiform and often sinuate tip, 2–4.5 mm long, 1/2–1/1 as long as loculi. *Gynoecium* about as long as or longer than stamens, exserted, 9–14.5 mm long, glabrous; ovary slightly contracted at base, narrower to slightly thicker than base of style; style straight, with 8 rather obscure longitudinal ridges at least on basal 1/2, often capitate but otherwise ± constant in thickness from base to tip; abscission zone basal; ovule 1. *Hypogynous glands* 4, equal. *Drupe* not known.

Derivation of epithet: From the Latin *filiformis*, threadlike, in reference to the filiform anther appendages which are unique in the genus.

Habitat: In yellow sand, often over laterite, in low heath; locally common.

Flowering period: November to December.

Distribution: (Fig. 29a) Irwin district: Arrowsmith River S to Badgingarra.

Conservation status: 2KC– (proposed here).

Variation: *P. filiformis* shows only minor between-population variation in flower size and in the ratio of anther-cell length to appendage length which, however, does not appear to be geographically or ecologically correlated.

Discussion: This species is a distinctive one, easily recognised by its filiform anther appendages. It most closely resembles *P. rudis* but differs in the above character as well as in its glabrous tepals and much shorter, appressed to antrorsely spreading hairs. It was first collected only in 1967, probably because of the difficulty of access to its whole distribution before the construction of the Brand Highway.

Selected specimens (11 examined): Irwin: Skipper Rd. 5.0 km E of Brand Highway 29° 38' S, 115° 16' E, *P.H. Weston 302*, Dec 1980 (SYD); 13.3 km S of Carnamah-Green Head road on Brand Highway, *C. Chapman s.n.*, Nov 1981 (SYD); W of Mt Peron c. 30° 06' S, 115° 07' E, *A.S. George 11200*, Nov 1971 (PERTH); Brand Highway 22 km N of Badgingarra 30° 13' S, 115° 24' E, *A. Strid 21703*, Dec 1982 (NSW); 5 miles [8 km] W of Badgingarra, *E. Wittwer 626*, Nov 1967 (KPBG).

33. Persoonia falcata *R. Br.*

(Brown 1810a: 162, 1810b: 373); Sprengel (1825: 473); Meisner (1856: 331); Bentham (1870: 385); Bailey (1901: 1324); Ewart & Davies (1917: 81); George (1981: 18).

Linkia falcata (R. Br.) Kuntze (Kuntze 1891: 579).

Type citation: 'In Novae Hollandiae orâ orientali; Endeavour River: Jos. Banks, bart.: septentrionali, Carpentaria; prope littora. (ubi v.v. cum fruct. matur. flor. delaps.)'

Lectotype (here designated): a sheet labelled 'No. 3293 14 Per*soonia falcata* prodr. 373 Carpentaria Island *k* Decr 20: 1802'; annotated by Brown (BM, photo NSW). The specimen on the upper right-hand side of the sheet is designated lectotype.

Residual syntype: Endeavour River, *Banks & Solander s.n.*, Jun-Aug 1770 (BM).

Erect shrub or small tree, usually with single main trunk, 1–9 m high, regenerating after disturbance from epicormic shoots or from lignotuber; underground parts not known. *Bark* deeply fissured, lamellose-flaky, with outside layers dark grey or black and inside layers reddish purple. *Hairs* short to medium length, antrorsely spreading to patent, greyish. *Branchlets* terete, glabrous to densely hairy when young but glabrescent with age. *Leaves* alternate, mostly oblanceolate to linear-oblanceolate but rarely narrow-spathulate or narrow-elliptical or linear, slightly to prominently asymmetrical, twisted at base so that most of laminae are held in ± vertical plane, flat or occasionally slightly convex, acute or acuminate or obtuse or mucronate or rarely emarginate, not pungent, (3–)8–35 cm long, (2–)4–30(–70) mm wide, sometimes crowded at end of season's growth, mostly patent to suberect, not usually curved in dorsiventral plane, soft to leathery and flexible, usually glaucous, concolorous, glabrous; venation brochidodromous; midvein evident to prominent on both surfaces; marginal veins evident to prominent; other veins obscure to

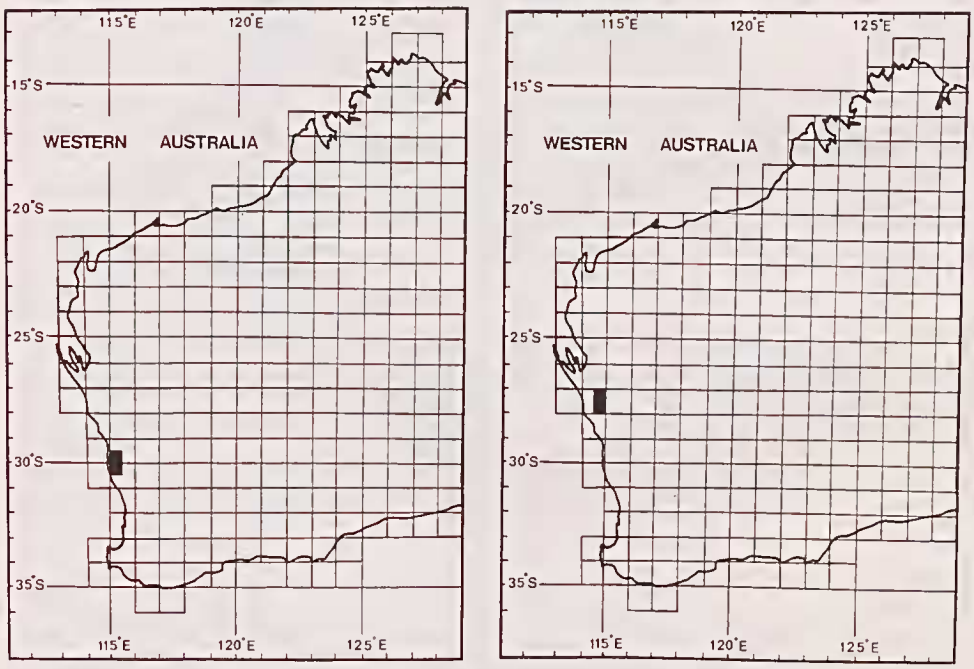

Figure 29. Distributions of **a**, *Persoonia filiformis* and **b**, *Persoonia biglandulosa*.

evident; epidermis smooth. *Scale leaves* triangular to narrow-triangular, acute, 1.4–4.5 mm long, 0.6–1.2 mm wide. *Inflorescences* mostly terminal or subterminal but occasionally axillary, auxotelic or anauxotelic, basitonic or pantotonic, (1–)10–80-flowered; rachis (0–)3–20 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 4–15 mm long, not consistently longer at base of inflorescence than at tip, glabrous to moderately or rarely densely hairy. *Tepals* acute to acuminate, pale creamy yellow to bright yellow, glabrous to moderately hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/2–2/3; lateral flaps absent; dorsal tepal oblanceolate to ± narrow-oblong, truncate at base, usually constricted below anther, 10–16 mm long, 1.5–3 mm wide; lateral tepals asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals; dorsal filament 4–6.5 mm long, 1/3–3/7 as long as dorsal tepal. *Anthers* white, introrse, held close together from their bases to tips of loculi, ± straight but reflexed through about 90° at appendage, ± straight, adnate to tepals for lower 1/3–3/5 of loculi; connective slightly narrower to slightly wider than loculi; loculi glabrous, 2.2–6 mm long; appendage ± narrow-triangular to narrow-oblong, 2–4.6 mm long, 1/2–7/5 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 4.5–6.5 mm long, glabrous; ovary slightly contracted at base, slightly thicker than base of style; style curved ± smoothly, not ridged, ± constant in thickness or slightly to distinctly tapered from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* globose to obovoid, smooth; long axis in line with stipe, in line with to slightly oblique to style; pyrene ellipsoid to obovoid, 11–15 mm long, 7–8.5 mm wide, smooth; seed 1 or rarely 2; embryo straight; cotyledons 6.

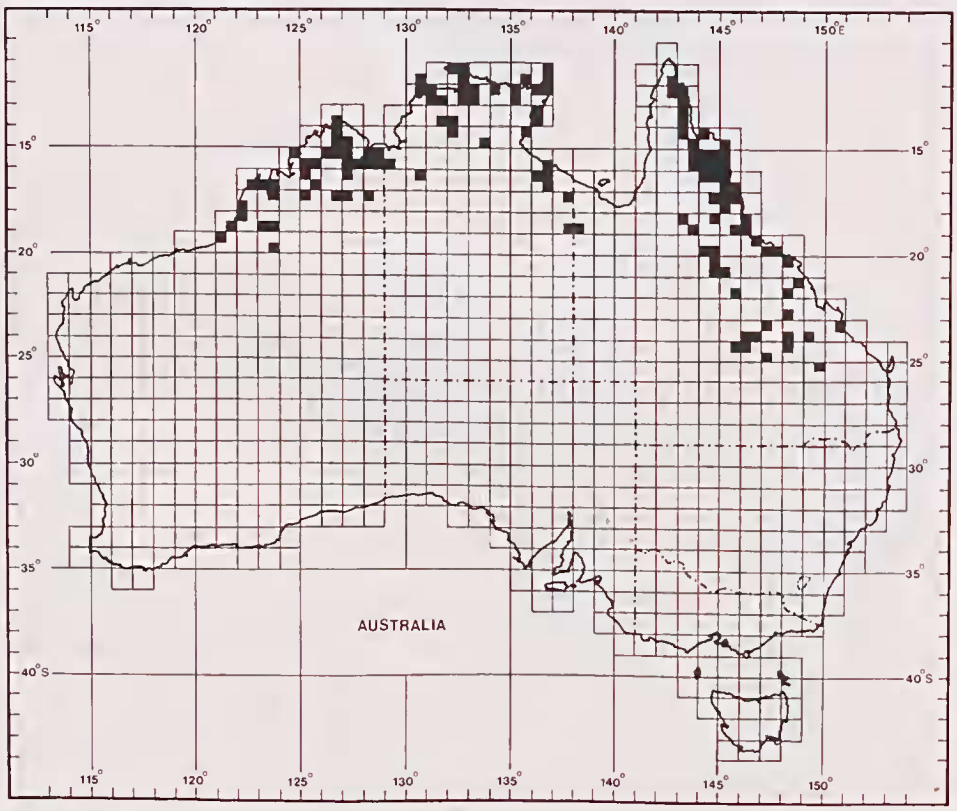

Figure 30. Distribution of *Persoonia falcata*.

Habitat: In well-drained situations: most commonly on sand which is often derived from sandstone or granite, or on dunes, but also on lateritic soils or on stony hillsides and rarely on clay, most commonly in *Eucalyptus* woodland to forest but also found in *Melaleuca* woodland or mixed woodland or margins of vine thickets and occasionally in heath; common throughout its range.

Flowering period: June to November.

Distribution: (Fig. 30) Northern Australia: from the Great Sandy Desert in Western Australia to the Blackdown Tableland in Queensland; mostly within 300 km of the coast.

Conservation status: Not rare.

Variation: *P. falcata* is extremely variable in leaf shape and dimensions and also varies to some extent in the hair density on young shoots and tepals and in several floral characters (e.g. flower size, ratio of anther cell length to anther appendage length). It might be expected that this variability would be correlated geographically across its widespread distribution but this does not appear to be the case: specimens showing extremes of variation have been collected throughout its distribution.

Discussion: This species is recognised easily by the combination of its lamellose and deeply fissured, dark grey bark and irregular flowers. It may be recognised by its leaves alone which are usually falcate and somewhat glaucous, with the midvein reaching the epidermis and with marginal veins.

Selected specimens (248 examined): Western Australia: Canning: McLarty Hills, Great Sandy Desert, 19° 30' S, 123° 30' E, *A.S. George 14726*, Aug 1977 (CANB, PERTH n.v.). Dampier: 7 miles [11 km] S of James Price Point, *R.C. Carolin 7497*, Jul 1970 (SYD). Fitzgerald: 12 miles [19 km] NNW of Elgie Cliffs Station, *M. Lazarides 6394*, Jul 1959 (AD, BRI, CANB, NSW, NT, PERTH). Gardner: Prince Regent River Reserve, 15° 20' S, 124° 56' E, *K.F. Kenneally 2129*, Aug 1974 (CANB, PERTH).

Northern Territory: Victoria River District: 109 miles [174 km] SE of Carlton Station, *R.A. Perry 3015*, Jul 1952 (AD, BRI, CANB, NSW, NT, PERTH). Darwin and Gulf: 47 miles [75 km] N of Oenpelli, *G. Chippendale 8124*, Jul 1961 (AD, BRI, CANB, NSW, NT, PERTH); Bartalumba Bay, Groote Eylandt, 13° 49' S, 136° 27' E, *C.R. Dunlop 2956*, Aug 1972 (CBG, NT). Barkly Tableland: Springvale, 18° 32' S, 137° 37' E, *A. Nicholls 635*, Aug 1967 (AD, BRI, NT).

Queensland: Burke: Murrays Spring, 18° 35' S, 138° 03' E, *P.K. Latz 1636*, Jul 1971 (CANB, NSW, NT). Cook: Bathurst Heads, 14° 15' S, 144° 10' E, *B. Hyland 4845*, Oct 1970 (BRI). North Kennedy: W of Pentland between Warrigal and Burra, *S.T. Blake 9923*, Oct 1935 (BRI). South Kennedy: 9 miles [15 km] W of Alpha, *Adams 1325*, Sep 1964 (CANB, BRI). Mitchell: c. 2 miles [3 km] N of Sydenham Station, SE of Lancevale, *L.S. Smith & S.L. Everist 952*, Oct 1940 (CANB, BRI). Leichhardt: SE slope of Ropers Peak, 22° 52' 00" S, 148° 13' 30" E, *P.H. Weston 1548 & P.G. Richards*, Jan 1990 (NSW). Port Curtis: Rockhampton, *R. Simmons s.n.*, 1903 (NSW).

34. Persoonia biglandulosa *P.H. Weston*, **sp. nov.**

Folia linearia, subteretia, (2–)5–10 cm longa, 1.0–1.3 mm lata, infra canaliculata. Flores irregulares. Gynoecium staminibus dimidio brevius, pars apicalis tepalo ventrali saccato obversa. Tepala lutea. Antherae albae. Glandulae hypogynae duae ventrales.

Holotype: Western Australia: Irwin: North West Coastal Highway, 45.8 km N of the Murchison River, 27° 25' S, 114° 40' E, *P.H. Weston 289*, 13 Dec 1980 (SYD). Isotypes: CANB, K, PERTH.

P. teretifolia R. Br. var. *amblyanthera* Benth. (Bentham 1870: 384). Type citation: 'Murchison River, Oldfield'. **Lectotype (here designated):** a sheet labelled 'Murchison River Oldfield F. Mueller 1870' (K, photo NSW). Three specimens are mounted on this sheet. The middle specimen is the lectotype. The other two are specimens

of *P. teretifolia* R. Br. var. *teretifolia*, and are not part of the type material. Isolectotype: PERTH.

Erect, spreading or decumbent shrub, with several to many stems branching from base or from underground, 0.15–1.5 m high; means of regeneration, underground parts not known. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to patent or curly, greyish to mid-brown. *Branchlets* slightly angular when immature but becoming terete when mature, densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, not twisted, subterete and grooved underneath, acute to acuminate, not pungent, (2–)5–10 cm long, 1.0–1.3 mm wide, sometimes crowded at end of season's growth, mostly suberect to erect, curved upwards slightly to prominently, leathery and flexible, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation hyphodromous; marginal veins absent; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 2.4–6.5 mm long, 0.7–1.6 mm wide. *Inflorescences* mostly terminal or subterminal, auxotelic, basitonic, (1–)8–25-flowered; rachis (0–)2.5–11 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 6–10 mm long, longer at base of inflorescence than at tip, densely hairy. *Tepals* acuminate, bright yellow, moderately hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/2; lateral flaps absent; dorsal tepal ± narrow-oblong to ± lanceolate, truncate at base, not constricted below anther, 10–13 mm long, 2–2.5 mm wide; lateral tepals prominently asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals; dorsal filament 4–5 mm long, 2/5–1/3 as long as dorsal tepal. *Anthers* white, introrse, held close together from their bases to tips of appendages, ± straight, adnate to tepals for about lower 2/5–1/6 of loculi, all fertile; connective slightly narrower than to slightly wider than loculi; loculi glabrous, 4–6 mm long; appendage ± oblong to ± triangular, 0.6–1.2 mm long, 1/4–1/7 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 4–5 mm long, glabrous; ovary slightly contracted at base, slightly thicker or no thicker than base of style; style curved ± smoothly, not ridged, tapering distinctly from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 2, ventral. *Drupe* ellipsoid to ovoid though often slightly compressed, smooth; long axis in line with or slightly oblique to stipe, in line with style; pyrene compressed-ellipsoid or compressed-ovoid, 11–14 mm long, 6–6.5 mm wide, smooth; seed 1; embryo straight; cotyledons 7–9.

Derivation of epithet: From the Latin *bi-*, two, and *glandulosus*, bearing little glands, in reference to the two hypogynous glands, a character this species shares with several others in contrast to the four equal glands found in most *Persoonia* species.

Habitat: In yellow sand, often over laterite, in low heath; in small populations.

Flowering period: October to December.

Distribution: (Fig. 29b). Irwin district: within 60 km of the mouth of Murchison River.

Conservation status: 2RC– (Briggs & Leigh 1988, as *Persoonia* sp.6).

Variation: Habit, leaf size and the density of hairs on young shoots and flowers varies between individuals. However, this variation does not seem to be ecologically or geographically correlated.

Discussion: *P. biglandulosa* is distinguished by the following characters: leaves linear, subterete and grooved underneath (i.e., revolute); flowers irregular; tepals moderately hairy on the outside; anthers white; dorsal hypogynous glands absent. *P. biglandulosa* was first described by Bentham as *P. teretifolia* var. *amblyanthera* but

differs from *P. teretifolia* in the leaf, anther and hypogynous gland characters mentioned above as well as in its longer hairs and shorter anther appendages.

Selected specimens (9 examined): Irwin: 393 mile peg North West Coastal Highway, *A.C. Burns 8*, Nov 1965 (PERTH); 12 km NE Hawks Head Lookout, Kalbarri, *D. & B. Bellairs 1708B*, Nov 1986 (PERTH); c. 40 km SE of Kalbarri, *D. & B. Bellairs 1708*, Nov 1978 (PERTH); just outside E boundary of Kalbarri National Park on Ajana road, 27° 55' S, 114° 35' E, *T.A. Halliday 141*, Nov 1974 (AD, AK n.v., CANB, PERTH).

35. Persoonia brachystylis *F. Muell.*

(Mueller 1868: 221); Bentham (1870: 385).

Linkia brachystylis (F. Muell.) Kuntze (Kuntze 1891: 579).

Type citation: 'Ad flumen Murchisoni in plagis arenosis. Oldf.'

Lectotype (here designated): on a sheet labelled 'Persoonia brachystylis FvM Murchison R. W. Aust. Oldf.' (MEL 103667, photo NSW). The specimen on the right-hand side of the sheet is designated lectotype. Isolectotypes: K (photo NSW), NSW.

Erect, spreading shrub, with several to many stems branching from base or from underground, 1–1.5 m high; means of regeneration, underground parts not known. *Bark* smooth but sometimes fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to patent, greyish to mid-brown. *Branchlets* terete, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, narrow-spathulate to linear-spathulate or linear-oblanceolate, symmetrical or slightly asymmetrical, not twisted, flat or convex, with recurved to revolute margins, acuminate to mucronate, not pungent, (3.5–)4.5–12 cm long, 2–10 mm wide, often crowded at end of season's growth, mostly patent to suberect, curved upwards slightly, leathery and flexible to rigid, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation brochidodromous; midvein evident to prominent on both surfaces; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 1.5–5 mm long, 1.0–1.7 mm wide. *Inflorescences* terminal or subterminal or axillary, auxotelic, basitonic, (1–)10–20-flowered; rachis (0–)7–25 cm long. *Flowers* mostly subtended by leaves, irregular, mostly held ± horizontally. *Pedicels* 7–15 mm long, not consistently longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* acuminate, bright yellow, moderately hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/2; lateral flaps absent; dorsal tepal ± narrow-oblong to. oblanceolate, truncate at base, not constricted below anther, 10–13 mm long, 1.5–2.5 mm wide; lateral tepals prominently asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals; dorsal filament 3.5–5 mm long, 2/5–1/3 as long as dorsal tepal. *Anthers* white, introrse, held close together from their bases to tips of appendages, ± straight, adnate to tepals for about lower 1/5–1/6 of loculi, all fertile; connective slightly narrower than to slightly wider than loculi; loculi glabrous, 3.5–5.5 mm long; appendage ± oblong to ± triangular, 0.8–1.0 mm long, 1/6–1/4 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 4–5 mm long, glabrous; ovary slightly contracted at base, slightly thicker or no thicker than base of style; style curved ± smoothly, not ridged, tapering distinctly from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 2, ventral. *Drupe* ellipsoid to ovoid but often compressed, smooth; long axis in line with or slightly oblique to stipe, in line with or slightly oblique to style; pyrene ellipsoid to ovoid and compressed, 10–12 mm long, 6–7 mm wide, smooth; seed 1; embryo straight; cotyledons 6–7.

Habitat: In yellow sand, often over laterite, in low heath; in small populations.

Flowering period: November to January.

Distribution: (Fig. 31a) Irwin district of Western Australia: Kalbarri National Park.

Conservation status: 2VC– (Briggs & Leigh 1988).

Variation: *P. brachystylis* is poorly sampled but there seems to be considerable variation between individuals with respect to leaf shape and dimensions. This does not seem to be ecologically or geographically correlated.

Discussion: This species is distinguished by the following set of characters: leaves narrow-spathulate to linear-spathulate or linear-lanceolate, with recurved to revolute margins; flowers irregular; tepals moderately hairy on the outside; anthers white; dorsal hypogynous glands absent. It most closely resembles *P. biglandulosa*, *P. stricta* and *P. comata* but may be distinguished from the former two by the above-mentioned leaf characters, from the third by the anther and gland characters and from all three by its inflorescences in which flowers are subtended almost exclusively by full-sized leaves. *P. brachystylis* was not collected between the 1860s and 1980, presumably because of its localised and (until recently) relatively inaccessible distribution.

Specimens examined: Irwin: Kalbarri National Park, 27° 36' S, 114° 26' E, *P.H. Weston 295*, Dec 1980 (PERTH, SYD); Kalbarri National Park, 27° 38' S, 114° 25' E, *P.H. Weston 296, 297*, Dec 1980 (PERTH, SYD).

36. Persoonia kararae *P.H. Weston*, **sp. nov.**

Folia (2–)8–14 cm longa, 3–3.5 mm lata, dorsiventraliter complanata. Rhachis ad 1.0 cm longa. Flores irregulares. Gynoecium staminibus dimidio brevius; pars apicalis tepalo ventrali saccato obversa. Tepala extus pilosa. Glandulae hypogynae duae ventrale.

Holotype: Western Australia: Austin: Karara boundary gate, *E. Wittwer 1592*, 28 Oct 1975 (PERTH). Isotype: KPBG.

Erect, spreading shrub, 1–5 m high; branching pattern, means of regeneration, underground parts not known. *Bark* not known. *Hairs* short to medium length, appressed to antrorsely spreading or curly, greyish. *Branchlets* terete, densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical or slightly asymmetrical, not twisted conspicuously, dorsiventrally flattened, acute, not pungent, (2–)8–14 cm long, 3–3.5 mm wide, often crowded at end of season's growth, patent to suberect, not curved in dorsiventral plane, leathery to soft and flexible, not glaucous, concolorous, glabrous to sparsely hairy when immature, glabrescent when mature; venation hyphodromous; midvein obscure to evident on both surfaces; marginal veins absent; other veins obscure; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 2–3.5 mm long, 1–1.5 mm wide. *Inflorescences* terminal or subterminal, mostly anauxotelic but occasionally auxotelic, pantotonic or basitonic, 1–10-flowered; rachis to 1.0 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 5–7 mm long, longer at base of inflorescence then at tip, moderately to densely hairy. *Tepals* acuminate, yellow, moderately hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/2; lateral flaps to 0.1 mm wide; dorsal tepal ± narrow-oblong, not constricted below anther, 11.5–13.5 mm long, 1.2–1.4 mm wide; lateral tepals asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals, 4–4.5 mm long, 1/3–2/5 as long as dorsal tepal. *Anthers* introrse, adnate to tepals for about lower 1/2 of loculi, all fertile; connective as wide as or slightly narrower than loculi; loculi glabrous, 6.5–7.5 mm long;

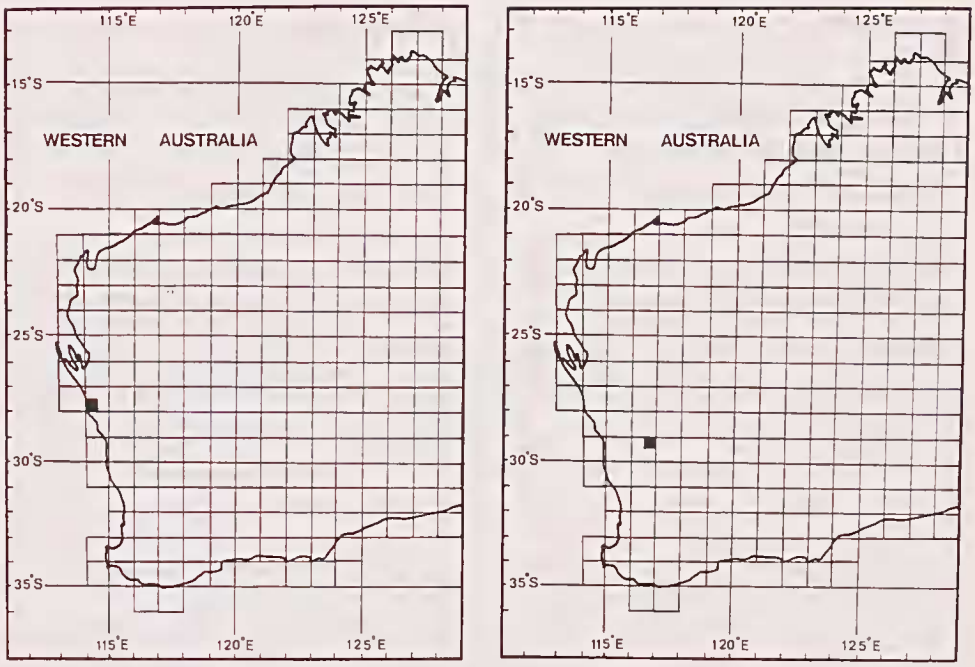

Figure 31. Distributions of a, *Persoonia brachystylis* and b, *Persoonia kararae*.

appendage ± oblong, 0.5–0.7 mm long, 1/10–1/15 as long as loculi; colour, position of anthers with respect to one another not known. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 5–5.5 mm long, glabrous; ovary slightly contracted at base, slightly to conspicuously thicker than base of style; style bent at base and near tip, not ridged, ± constant in thickness or slightly tapering from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 2, ventral. *Drupe* ± globose, smooth; long axis in line with or slightly oblique to stipe, in line with or slightly oblique to style; pyrene, seed not known.

Derivation of epithet: In reference to Karara pastoral station, from where the only two collections were taken.

Habitat: Sand-plain.

Flowering period: September to November.

Distribution: (Fig. 31b) Austin district: Karara Station.

Conservation status: 2K (Briggs & Leigh 1988, as *Persoonia* sp.7).

Variation: This species is poorly sampled and variation within each collection seems to be no greater than that between them.

Discussion: *P. kararae* is distinguished by the following combination of characters: leaves linear, dorsiventrally flattened but without prominent longitudinal ridges; flowers irregular; tepals moderately hairy on the outside; dorsal hypogynous glands absent. It most closely resembles *P. stricta* but may be distinguished from that species by the more densely hairy tepals as well as by its more patent leaves, its shorter, mostly anauxotelic inflorescences and its narrower tepals. Both specimens were originally identified as *P. saundersiana* but they differ from that species in the leaf, tepal and inflorescence characters mentioned above.

Specimen examined: Austin: Karara Station, *J.S. Beard 7198*, Oct 1974 (PERTH).

37. Persoonia stricta *C.A. Gardner ex P.H. Weston*, **sp. nov.**

Folia (1.7–)6–15 cm longa, 2.5–8 mm lata, complanata, distincte non canaliculata. Flores irregulares. Gynoecium staminibus dimidio brevius; pars apicalis tepalo ventrali saccato obversa. Tepala lutea, extus glabra vel pilis sparsis. Anthera alba. Glandulae hypogynae 2 vel 4.

Holotype: Western Australia: Avon: Manmanning, *C.A. Gardner 2728*, 24 Sep 1931 (PERTH). Isotype: NSW.

Erect, spreading shrub, usually with several to many stems branching from base, 1–5 m high; means of regeneration, underground parts not known. *Bark* smooth but usually fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to patent or curly, greyish. *Branchlets* angular when immature but becoming terete when mature, glabrous to densely hairy when young but glabrescent with age. *Leaves* alternate, linear-spathulate to linear-oblong, symmetrical or slightly asymmetrical, sometimes slightly twisted, flat, acute or acuminate or obtuse or mucronate, not pungent, (1.7–)6–15 cm long, 2.5–8 mm wide, often crowded at end of season's growth, suberect to erect, often curved upwards slightly, leathery and flexible, occasionally slightly glaucous, concolorous, glabrous to sparsely hairy when immature, glabrescent when mature; venation hyphodromous or brochidodromous or acrodromous; midvein obscure to evident on both surfaces; marginal veins absent; secondary and tertiary veins obscure to evident on both surfaces; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 1.5–8 mm long, 0.5–1.5 mm wide. *Inflorescences* mostly terminal or subterminal, auxotelic or anauxotelic, pantotonic or basitonic, (1–)4–25-flowered; rachis (0–)0.3–10 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 4–10 mm long, longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* acuminate to mucronate, bright yellow, glabrous to sparsely hairy on outside, glabrous on inside except for marginal rows or patches of hair-like papillae on proximal 1/2; lateral flaps absent; dorsal tepal ± narrow-oblong to ± oblanceolate, truncate at base, not constricted below anther, 11–16 mm long, 1.5–3 mm wide; lateral tepals prominently asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals; dorsal filament 4.5–6 mm long, 1/3–2/5 as long as dorsal tepal. *Anthers* white, introrse, held close together from their bases to tips of appendages, ± straight, adnate to tepals for lower 1/6–1/2 of loculi, all fertile; connective slightly narrower to slightly wider than loculi; loculi glabrous, 4–7.5 mm long; appendage ± oblong to ± triangular, 1–2 mm long, 1/5–1/2 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 5–7.5 mm long, glabrous or rarely sparsely hairy; ovary slightly contracted at base, slightly to conspicuously thicker than base of style; style abruptly bent at base and near tip, not ridged, ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 2 or 4, dorsal pair much reduced or absent. *Drupe* ellipsoid, smooth; long axis slightly oblique to stipe, slightly oblique to style; pyrene ellipsoid and often slightly compressed, 8.5–11 mm long, 5.5–7 mm wide, smooth; seed 1 or rarely 2; embryo straight; cotyledons 7–9.

Derivation of epithet: From the Latin *strictus*, very upright, in reference to the upward-pointing leaves.

Habitat: In yellow sand or sandy loam, often over laterite, in heath or *Allocasuarina* and/or *Acacia* thicket or *Eucalyptus* woodland; locally common.

Flowering period: August to December.

Distribution: (Fig. 32a) Irwin and Avon districts: from the Ajana area to Manmanning.

Conservation status: Not rare.

Variation: Within this species, geographically correlated variation in leaf size and morphology is shown. The extreme southern form (Manmanning area) has relatively long (mostly over 9 cm long), wide (6–8 mm wide), linear-spathulate leaves with evident secondary and tertiary veins. This grades into a more northern (Perenjori–Bunjil area) form with narrower (2.5–4.5 mm wide) linear-oblong leaves with less evident to obscure secondary veins and obscure tertiary veins. The extreme northern form (Ajana–Geraldton area) has shorter (mostly less than 9 cm long), narrow (2.5–4 mm wide), linear-spathulate leaves with obscure secondary veins. Specimens from the Winchester area are intermediate in leaf characters between the Perenjori–Bunjil and Ajana–Geraldton forms. Gardner (as shown by annotated herbarium sheets) classified the Ajana–Geraldton forms as *P. saundersiana* var. *laevis* and the Perenjori–Manmanning forms as *P. saundersiana* var. *stricta*. These names were published (though not validly so) by Blackall and Grieve (1954). I have not recognised these forms as separate taxa because they evidently intergrade. Flower size varies to some extent within and between populations but this does not appear to be geographically correlated. Specimens from the Winchester area have more densely hairy branchlets, pedicels and scale leaves than do other populations, among which variation in hair density is negligible.

Discussion: *P. stricta* may be recognised by the following combination of characters: leaves flat, without prominent longitudinal ridges or grooves; flowers irregular; tepals glabrous to sparsely hairy on the outside; anthers white; dorsal hypogynous glands much reduced or absent. It closely resembles *P. saundersiana* and *P. kararae*. From the former it is distinguished by the abovementioned leaf characters and from the latter by its less densely hairy tepals. It has been confused with *P. comata* but differs from that species in the abovementioned characters as well as in lacking spreading, underground rhizomes and in being a much taller shrub. *P. stricta* and *P. saundersiana* have parapatric distributions with a 'boundary line' running between

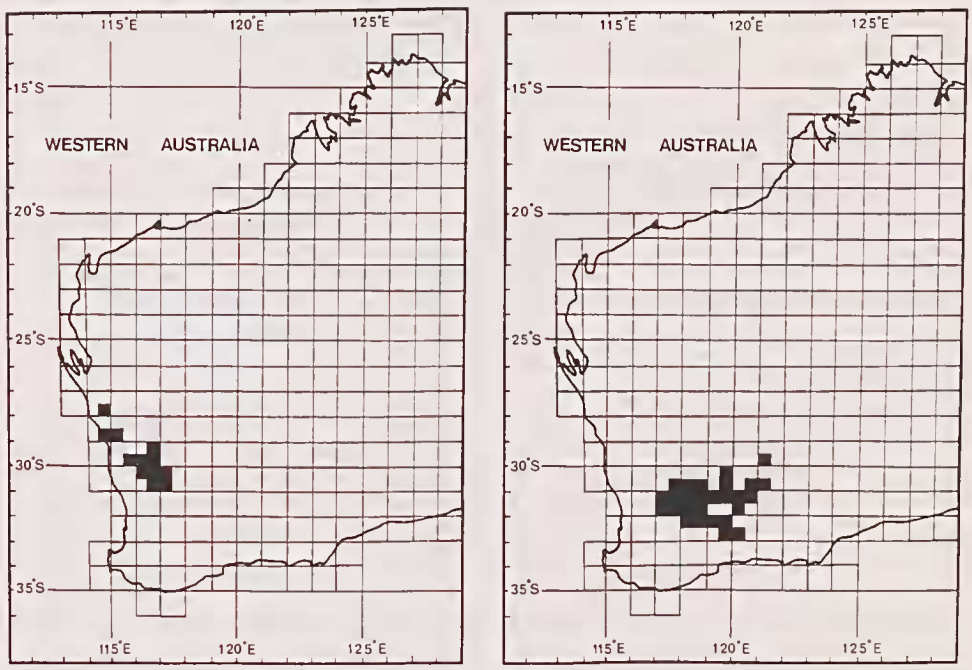

Figure 32. Distributions of **a**, *Persoonia stricta* and **b**, *Persoonia saundersiana*.

Cowcowing Lakes and the Manmanning–Minnivale area. This boundary has been almost totally cleared for agriculture; intermediate populations, if any ever existed, would have been destroyed.

Selected specimens: Irwin: 390 to 394 mile pegs on North West Coastal Highway, *A.C. Burns 1057*, Oct 1966 (PERTH); Geraldton district, *A.C. Burns 2*, Nov 1963 (PERTH); N of Tenindewa, *A.M. Ashby 2275*, Aug 1967 (AD, PERTH); SW of Winchester, *C. Chapman s.n.*, Sep 1969 (PERTH, SYD). Avon: rabbit-proof fence east of Perenjori, *C.A. Gardner 12080*, Sep 1953 (PERTH); junction of Bunjil–Waddi Forest and Latham–Waddi Forest roads, 29° 51' S, 116° 14' E, *P.H. Weston 306*, Dec 1980 (SYD); 3 miles [5 km] NNW of Buntine, *R. Melville 4299*, Jul 1953 (AD, K, NSW, PERTH); Wubin School, *F. Lullfitz 1453*, Jul 1963 (KPBG); Reynoldson's Flora Reserve Wongan Hills, *J.S. Beard 5128*, Oct 1967 (PERTH); between Manmanning and Cadoux, 30° 48' S, 117° 07' E, *P.H. Weston 317*, Dec 1980 (SYD).

38. Persoonia saundersiana *Kippist*

(Kippist in Meisner 1855: 72); Meisner (1856: 330); Bentham (1870: 384).

Linkia saundersiana (Kippist) Kuntze (Kuntze 1891: 579).

Type citation: 'Drummond, coll. v. Suppl. n.4.'

Lectotype (here designated): A sheet labelled '1155. *Persoonia* (Sacculigera) *Saundersiana*, Kipp. Swan R. J. Drummond. Ser. 5, supp. 4. — Pres[d]. by W.W. Saunders, Esq.' (K, photo NSW). Isolectotypes: BM (2 sheets), CGE, Fl, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, PERTH, TCD.

Meisner (1855) cited this species as 'Persoonia (Sacculigera) *Saundersiana*, Kipp. in litt.' and noted 'I have not seen this species' (Meisner 1855: 72). As argued by Barker & Barker (1990), authorship of this name should be attributed solely to Kippist, not 'Kippist ex Meisner' (cf. Jackson (1894), Chapman (1991)). Not surprisingly, I could not find a specimen of *P. saundersiana* in Meisner's herbarium at NY.

P. diadena F. Muell. (Mueller 1876: 46). Type citation: 'Ad montem Churchmanii cum *P. comata*; Young.' **Lectotype (here designated):** on a sheet labelled 'Persoonia [trigonophylla crossed out] diadena FvM Near Mt Churchman Young' (MEL 103665, photo NSW). The specimen on the right-hand side of the sheet is designated lectotype. The specimen on the left-hand side of the sheet is a specimen of *P. angustiflora*, and is not part of the type material. Isolectotype: K.

Erect, spreading shrub, usually with several to many stems branching from or near base, 0.5–5 m high; means of regeneration, underground parts not known. *Bark* smooth but often fissured and excorticating at base, compact, mottled grey. *Hairs* of medium length, appressed to patent or curly, greyish. *Branchlets* angular when immature but becoming terete when mature, glabrous to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical or slightly asymmetrical, sometimes slightly twisted, dorsiventrally flattened with 2 or 4 grooves on both surfaces or ± triangular in cross-section with 2 grooves on both surfaces or ± triangular to ventrally plano-convex in cross-section without grooves or ± subterete with single groove underneath, acute to acuminate, not pungent, (1.5–)4–21 cm long, 1.0–3.2 mm wide, often crowded at end of season's growth, patent to erect, not curved upwards or curved upwards slightly to very prominently (to 230°), leathery and rigid to flexible, sometimes glaucous, concolorous, glabrous to sparsely hairy when immature, glabrescent when mature; venation parallelodromous or hyphodromous; midvein obscure to prominent on both surfaces, more prominent than other veins and often more prominent on adaxial surface; marginal veins absent; 1 or 2 pairs of secondary veins often evident to prominent on both surfaces innermost pair always more prominent than outside pair; other veins obscure; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 1.5–10 mm long,

0.7–1.5 mm wide. *Inflorescences* mostly terminal or subterminal, auxotelic, basitonic, 1–25-flowered; rachis to 10 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 3.5–20 mm long, longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* acuminate to mucronate, bright yellow, glabrous to sparsely hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/3–2/3; lateral flaps absent; dorsal tepal ± narrow-oblong to ± oblanceolate, truncate at base, sometimes slightly constricted below anther, 9.5–14 mm long, 1.5–2.5 mm wide; lateral tepals prominently asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals; dorsal filament 2.8–4.6 mm long, 1/3–2/5 as long as dorsal tepal. *Anthers* white, introrse, held close together from their bases to tips of appendages, ± straight, adnate to tepals for lower 1/4–1/2 of loculi, all fertile; connective slightly narrower than to slightly wider than loculi; loculi glabrous, 3.2–7.4 mm long; appendage ± oblong to ± triangular, 0.8–2.0 mm long, 1/7–2/5 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 4–6.5 mm long, glabrous or very rarely sparsely hairy; ovary slightly contracted at base, slightly to conspicuously thicker than base of style; style abruptly bent at base and near tip, not ridged, ± constant in thickness from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 2 or 4, dorsal pair much reduced or absent. *Drupe* ellipsoid and sometimes slightly compressed, smooth, long axis slightly oblique to stipe, slightly oblique to style; pyrene ellipsoid to obovoid and often slightly compressed, 7–11 mm long, 5–7.5 mm wide, smooth; seed 1 or rarely 2; embryo straight; cotyledons 6–9.

Habitat: In sand to loam, often over laterite, frequently in shrub-thicket communities dominated by *Allocasuarina campestris* and/or *Acacia* spp., or in heath or mallee-heath; usually in small populations.

Flowering period: Mostly September to November though occasionally as early as July.

Distribution: (Fig. 32b) South-western Australia: an area roughly bounded by Minnivale, Tammin, Lake Hope and Comet Vale.

Conservation status: Not rare.

Variation: *P. saundersiana* shows minor variation in a few floral characters but this does not seem to be geographically correlated. However, this species does show a high degree of geographical variation in leaf morphology. The populations on the far eastern side of the distribution (Comet Vale – Coolgardie – Mt Holland – Southern Cross area) have leaves which are mostly 6–14 cm long, 1.5–2.1 mm wide, usually curved upwards slightly (to about 90°), ventrally plano-convex to triangular in cross-section with the midvein evident to prominent on the lower surface. West of Southern Cross these gradually grade into 'curly-leaved' populations which are exemplified by populations in the Carrabin – Bodallin area with leaves which are mostly 4–8 cm long, 1–1.5 mm wide, curved upwards prominently (90°–230°), subterete and grooved underneath. The far western populations (Minnivale – Tammin – Kellerberrin) have leaves which are mostly 10–21 cm long, 2–3 mm wide, sometimes curved upwards slightly, dorsiventrally flattened with 2 or 4 grooves on both surfaces, the midvein equally prominent on both surfaces. This 'western form' grades into the extreme curly-leaved eastern form in the Mukinbudin – Merredin – Narembeen area. Some of these intermediates closely resemble the far eastern forms in leaf morphology.

Discussion: *P. saundersiana* most closely resembles *P. stricta* and *P. kararae* but is most easily distinguished from both of those species by its leaves which are either longitudinally ribbed or ± triangular to subterete in cross-section. From the latter species it is also distinguished by its less densely hairy tepals and its usually longer,

auxotelic inflorescences. From all other species it is distinguished by a combination of the abovementioned characters and its irregular flowers.

Selected specimens (80 examined): Avon: Waddouring, *W.B. Alexander 1278*, Oct 1915 (PERTH); 4.9 miles [8 km] W of Minnivale beside railway line, 31° 09' S, 117° 07' E, *P.H. Weston 319*, Dec 1980 (SYD, NSW, PERTH); near Tammin, *C.A. Gardner 1128*, Nov 1920 (PERTH); Muntadgin, *T.W. Stone 875*, Sep 1947 (CANB, PERTH). Austin: Comet Vale, *C.A. Gardner 13458*, Sep 1961 (PERTH). Coolgardie: 20 km E of Southern Cross, *R.H. Kuchel 2116*, Sep 1964 (PERTH); [Great] Eastern Highway 31 miles [50 km] W of Coolgardie, *J.H. Willis s.n.*, Oct 1961 (MEL, NSW, PERTH); Lake Barker Reserve, *W.H. Butler s.n.*, Nov 1971 (PERTH). Roe: near Mt Holland, *A. Fairall 2450*, Oct 1967 (CANB, PERTH); between Lake Hope and Hatters Hill, *W.E. Blackall 1262*, Nov 1931 (PERTH).

39. Persoonia teretifolia *R. Br.*

(Brown 1810a: 160, 1810b: 372); Sprengel (1825: 472); Meisner (1856: 329); Bentham (1870: 383).

Linkia teretifolia (R. Br.) Kuntze (Kuntze 1891: 579)

Pycnonia teretifolia (R. Br.) L.A.S. Johnson & B.G. Briggs (Johnson & Briggs 1975: 175)

Type citation: 'In Novae Hollandiae orâ australi; Lewins Land: in collibus saxosis. (ubi v.v.)'

Lectotype (here designated): a sheet labelled 'No. 3292 R. Brown May 30 1803 Loc: Bay I ora australis'; annotated by Brown (BM, photo NSW). The specimen on the lower right-hand corner of the sheet is designated lectotype. Isolectotypes: K (photo NSW), NSW.

The combination of locality ('Bay I', i.e. Lucky Bay) and date cited on the type sheet is erroneous. Brown collected at Lucky Bay in January 1802, and at Goose-Island Bay, east of Lucky Bay, in May 1803 (Stearn 1960). It seems most likely that the cited date is wrong because January is the peak of the flowering season for P. *teretifolia*, and the type specimens have both flowers and buds. Flowering material of this species has only occasionally been collected in May.

P. scoparia Meisn. [Meisner (1852: 185) nom. nud.] (Meisner 1856: 329); Type citation: 'In colonia Swan River (Drummond coll. 4, n. 276!) ... (v.s. in herb. Shuttleworth)'. **Lectotype (here designated):** a sheet labelled by Meisner '*Persoonia scoparia* Meisn. (29. Jun. 1850.) Drummond Coll. 1848. n. 276! hb. Shuttl.' (NY). Isolectotypes: BM, G (n.v., photo NSW), G-DC (n.v., photo NSW), K, MEL.

Erect, spreading shrub, with many stems branching from base, 0.5–3 m high; means of regeneration, underground parts not known. *Bark* smooth, compact, mottled grey. *Hairs* short to medium length, appressed to patent or curly, greyish. *Branchlets* terete, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, not twisted, terete, acute to acuminate, not pungent, (0.5–)1.5–7 cm long, 0.9–1.5 mm wide, often crowded, mostly suberect to erect, curved upwards slightly to prominently, leathery and rigid to rather flexible, not glaucous, concolorous, glabrous to sparsely hairy when immature, glabrescent when mature; venation hyphodromous; marginal veins absent; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 1–5 mm long, 0.6–1.0 mm wide. *Inflorescences* mostly terminal or subterminal, auxotelic or rarely anauxotelic, basitonic, 1–20-flowered; rachis to 10 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 2–6 mm long, not consistently longer at base of inflorescence than at tip, densely hairy. *Tepals* acute, bright yellow, sparsely to densely hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/2; lateral flaps absent; dorsal tepal

± narrow-oblong to ± narrow-triangular, not constricted below anther, 9–13 mm long, 1.5–3 mm wide; lateral tepals slightly asymmetrical; ventral tepal saccate below anther. *Filaments* adnate to tepals; dorsal filament 3–4 mm long, 1/4–2/5 as long as dorsal tepal. *Anthers* pale to bright yellow with white tips, introrse, held close together from their bases to tips of loculi, ± straight but reflexed through about 90° at appendage, adnate to tepals for about lower 1/3–3/4 of loculi; connective slightly narrower than to slightly wider than loculi; loculi glabrous, 3.3–5.6 mm long; appendage ± narrow-oblong, 1.7–2.7 mm long, 2/3–2/5 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 4–5.5 mm long, glabrous; ovary slightly contracted at base, slightly thicker than base of style; style curved ± smoothly, not ridged, tapering distinctly from base to tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid or obovoid or ovoid, smooth; long axis in line with or slightly oblique to point of attachment, in line with or slightly oblique to style; pyrene ellipsoid to obovoid or ovoid, 7.5–13.5 mm long, 4–5.5 mm wide, smooth; seed 1; embryo straight; cotyledons 5–8.

Habitat: In yellow or white sand to clay, often over laterite, in low heath or mallee-heath communities; common throughout its range.

Flowering period: Mostly October to February.

Distribution: (Fig. 33a) South-western Australia: between Albany and Israelite Bay; mostly within 100 km of coast.

Conservation status: Not rare.

Variation: This is a coherent species showing only minor variation between populations with respect to leaf length, degree of leaf curvature, flower size and flower ratio characters, and flower colour. This variation does not appear to be geographically correlated.

Discussion: *P. teretifolia* is distinguished readily by its truly terete leaves and irregular flowers. *P. biglandulosa* was included in *P. teretifolia* as a variety by Bentham (1870) but is quite distinct (see the discussion of *P. biglandulosa* for the differences).

Selected specimens (62 examined): Darling: Albany, *W.E. Blackall s.n.*, Dec 1937 (PERTH). Roe: 19.8 km E of rabbit-proof fence on Hyden–Norseman road, 32° 25' S, 119° 38' E, *P.H. Weston 335*, Dec 1980 (SYD, NSW, PERTH); 20 km NE of Swallow Rock, 32° 53' S, 120° 24' E, *K. Newbey 6856*, Aug 1980 (PERTH); 25 km NW of Roberts Swamp, 33° 04' S, 121° 10' E, *K. Newbey 8194*, Nov 1980 (PERTH); 16.3 km W of Newdegate, 33° 06' S, 118° 51' E, *P.H. Weston 254*, Dec 1980 (SYD, PERTH); 1.5 km S of Tower Peak, 33° 20' S, 123° 28' E, *M.D. Crisp 4855*, Jan 1979 (CBG); Eyre: 19 km S of Ravensthorpe, 33° 41' S, 120° 11' E, *A.E. Orchard 4428*, Dec 1974 (AD, AK n.v., CANB, PERTH); Fitzgerald River Valley E of Roes Rock, 33° 59' S, 119° 24' E, *A.S. George 10531*, Dec 1970 (PERTH); c. 1 mile N of Thistle Cove, *A.S. George 7544*, Jan 1966 (PERTH); Albany–Borden Highway near Kamballup, 34° 35' S, 118° 00' E, *A. Strid 21843*, Dec 1982 (NSW).

40. Persoonia comata *Meisn.*

(Meisner 1855: 71); Meisner (1856: 330); Bentham (1870: 385); Weston (1987: 349).

Linkia comata (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'Drummond, coll. vi. n. 178.'

Lectotype (here designated): A specimen labelled by Meisner *'Persoonia* (Sacculigera) *comata* nob. (9. Nov. 1854.) Interior North of Swan River A. 1850-51. legit. Drummond, Coll. Vl N° 178! D.am. Shuttleworth Nov. 1854.' (NY). Isolectotypes: B, BM, CGE, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), L, MEL (2 sheets), NSW, PERTH.

Erect sometimes spreading to decumbent shrub with 1 to many stems branching from underground, 0.2–1.5 m high, regenerating after disturbance from lignotuber, with spreading ± horizontal grossly thickened rhizome just beneath soil surface, forming clump, with single thickened taproot. *Bark* smooth but sometimes flaky towards base, compact, grey. *Hairs* of medium length, antrorsely spreading to patent or curly, greyish. *Branchlets* sometimes angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, oblanceolate or linear-oblanceolate or narrow-spathulate or linear-spathulate, symmetrical to slightly asymmetrical, sometimes slightly twisted, flat or slightly concave or convex but often with recurved margins, acute or acuminate or obtuse or mucronate or emarginate, not pungent, (2.5–)5.5–15 cm long, 2.5–17.5 mm wide, often crowded at end of season's growth, mostly suberect to erect, often curved upwards slightly, leathery and rigid to flexible, sometimes rather glaucous, concolorous, glabrous to moderately hairy when immature; venation brochidodromous; midvein evident to prominent on both surfaces; marginal veins absent; other veins evident on both surfaces; epidermis papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 1–8 mm long, 0.8–2 mm wide. *Inflorescences* mostly terminal or subterminal, usually auxotelic, basitonic but mesotonic to acrotonic in newly regenerating shoots, (1–)10–50(–90)-flowered; rachis (0–)2–25(–45) cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 5–25 mm long, longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* obtuse or acute or acuminate, bright yellow but often tinged with pink, moderately to densely hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 2/3; lateral flaps absent; dorsal tepal ± narrow-oblong to oblanceolate, truncate at base, not constricted below anther, 9–15 mm long, 1.5–3.0 mm wide; lateral tepals prominently asymmetrical; ventral tepal deeply saccate below anther. *Filaments* adnate to tepals; dorsal filament 4.2–6.3 mm long, 1/2–2/5 as long as dorsal tepal. *Anthers* bright yellow with white tips, introrse, held close together from their bases

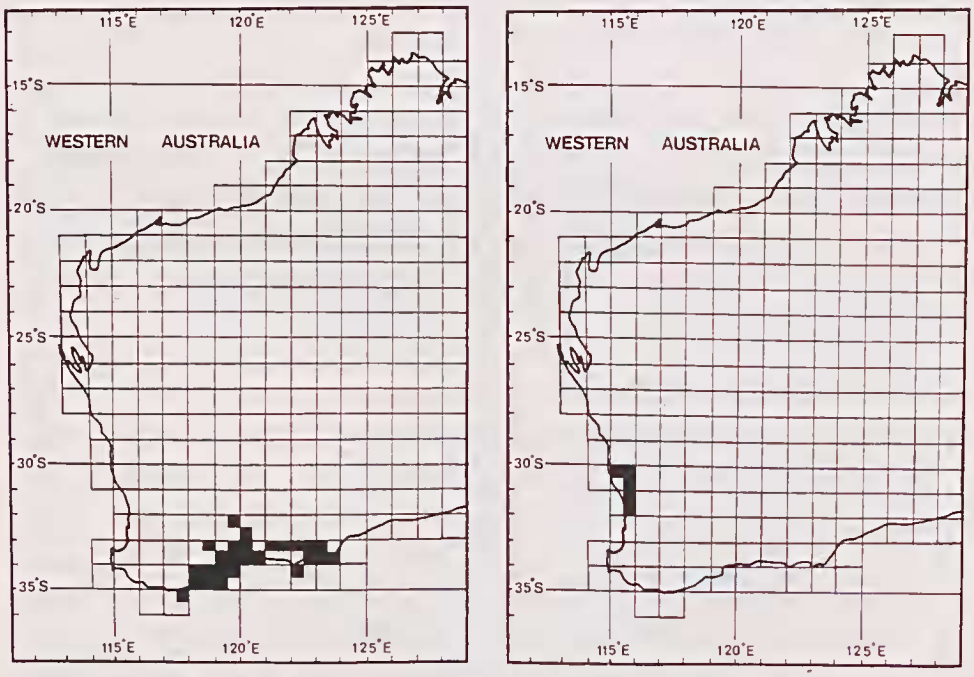

Figure 33. Distributions of **a**, *Persoonia teretifolia* and **b**, *Persoonia comata*.

to tips of appendages, ± straight, free or basally adnate to tepals to lower 1/2 of loculi, all fertile; connective slightly narrower than to slightly wider than loculi; loculi minutely ciliate, 3.5–5.5 mm long; appendage ± oblong to ± triangular, 0.8–3.0 mm long, mostly 3/5–1/4 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 5.5–6.5 mm long, glabrous; ovary slightly contracted at base, slightly thicker or no thicker than base of style; style curved ± smoothly or sometimes bent ± abruptly at base, not ridged, usually slightly thickened towards tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to obovoid though sometimes slightly compressed, smooth; long axis in line with stipe, in line with or slightly oblique to style; pyrene ellipsoid to obovoid and often compressed, 8.5–11.5 mm long, 5–7 mm wide, smooth; seed 1; embryo straight; cotyledons 7–9.

Habitat: In grey or yellow sand, often over laterite, in *Eucalyptus* forest to woodland or *Banksia* forest to woodland or mallee-heath to low heath; often locally common.

Flowering period: November to February.

Distribution: (Fig. 33b) Darling and Irwin districts: from Mt Peron south to Yanchep.

Conservation status: Not rare.

Variation: Several characters vary in a north–south cline within *P. comata*. The extreme ends of this cline may be characterised as follows: northern end (Eneabba area): leaves oblanceolate to narrow-spathulate, usually rather rigid, moderately hairy when immature; tepals densely covered with patent hairs (which are longer than those of southern plants); dorsal tepal 14–15 mm long; southern end (Yanchep area): leaves linear-oblanceolate to linear-spathulate, usually quite flexible, glabrous to sparsely hairy when immature; tepals moderately covered with antrorsely spreading to curly hairs; dorsal tepal 10–11 mm long. In the intervening areas a range of variation links these extremes.

Discussion: This species may be distinguished by the following combination of characters: leaves oblanceolate to linear-oblanceolate to narrow-spathulate to linear-spathulate; flowers irregular; tepals moderately to densely hairy on the outside; ventral tepal deeply saccate; anthers yellow with white tips; hypogynous glands 4, equal. It most closely resembles *P. saccata* but differs from that species by its wider leaves and other, more subtle floral characters. These species have almost parapatric distributions but no intermediate populations are known. *P. comata* also resembles *P. brachystylis* and some forms of *P. stricta* superficially but differs from these species in tepal, anther and gland characters.

Selected specimens (29 examined): Irwin: Dinner Hill, *A.M. Ashby 733*, Nov 1963 (AD); intersection of Green Head road and Brand Highway, 30°03' S, 115°20' E, *B. Barnsley 854* (PERTH). Darling: 17 km W of turnoff on road to Jurien Bay from Gingin-Eneabba road, *G.J. Keighery 576*, Oct 1975 (KPBG); W of Moora, *T.E.H. Aplin 1300*, Nov 1961 (PERTH); Brand Highway 31 km N of junction with Wanneroo-Gingin road, 31°05' S, 115°45' E, *P.H. Weston 270*, Dec 1980 (SYD); Moore River road N of Yanchep National Park, *N.T. Burbidge 8045*, Jan 1973 (CANB, NSW, PERTH); Muchea, *W.V. Fitzgerald s.n.*, Feb 1904 (NSW, PERTH).

41. Persoonia saccata *R. Br.*

(Brown 1830: 12); Meisner (1856: 329); Bentham (1870: 384); Weston (1987: 350).

Linkia saccata (R. Br.) Kuntze (Kuntze 1891: 579).

Type citation: 'Ora occid.? ex Herb. Mus. Paris., in it. Baudin lecta.'

Lectotype (here designated): A specimen labelled '*Persoonia saccata* RB *P. teretifolia* prodr or occident Sharks Bay. Herb. Mus Paris'; annotated by Brown (BM, photo NSW).

The collection locality cited on the label of the type sheet is clearly an error. Shark Bay is over 600 km north of the known northern limit of *P. saccata* and is an environment in which *P. saccata* is most unlikely to survive. However, Baudin's expedition collected specimens of terrestrial plants within the known distribution of *P. saccata*, at two localities in Geographe Bay, near Cape Naturaliste and at Wonnerup Estuary (Horner 1987). The type was most probably collected at one of those sites.

P. fraseri R. Br. (Brown 1830: 14). Type citation: 'Ora merid.-occid., Swan River, 1827. *D. Fraser.*' **Lectotype (here designated):** a sheet labelled 'Swan River Fraser recd 1828'; annotated by Brown (BM, photo NSW). Five specimens are mounted on this sheet in two groups. The two specimens on the right-hand side are parts of *Drummond 597* (i.e., they are specimens of *P. angustiflora*) and are not part of the type material. Of the three specimens on the left-hand side of the sheet, the right-hand (largest) one is designated lectotype. Isolectotype: K (photo NSW).

Note: *P. fraseri* R. Br. was misapplied by Meisner to specimens subsequently described as *P. angustiflora* Benth.

P. macrostachya Lindl. (Lindley 1840: 35); Meisner (1845: 531); Meisner (1856: 330). Type citation: none given. **Lectotype (here designated):** a sheet labelled 'Swan River. Drummond, 1839' (CGE, photo NSW). The specimen on the right-hand side of the sheet and labelled 'Lectotype of *Persoonia macrostachya* Lindl. det. A. S. George 13.viii.1968.' is designated lectotype. Isolectotypes: CGE (photo NSW), FI.

Erect, sometimes spreading to decumbent shrub with 1 to many stems branching from underground, 0.2–1.5 m high, regenerating after disturbance from lignotuber, with spreading ± horizontal grossly thickened rhizome just beneath soil surface, forming clump, apparently with single thickened taproot. *Bark* smooth but sometimes flaky towards base, compact, grey. *Hairs* of medium length, antrorsely spreading to patent or curly, greyish. *Branchlets* sometimes angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent with age. *Leaves* alternate, linear, symmetrical, not twisted, dorsiventrally compressed or flat with recurved to revolute margins or subterete and grooved underneath, acuminate, not pungent, (1–)5–17 cm long, 0.8–1.4 mm wide, often crowded, patent to erect, usually curved upwards slightly, soft to leathery and flexible, sometimes glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation hyphodromous; midvein obscure on both surfaces or evident on abaxial surface; marginal veins absent; other veins obscure; epidermis smooth to slightly papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute to acuminate, 1–9.5 mm long, 0.7–1.3 mm wide. *Inflorescences* terminal or subterminal or axillary, usually auxotelic, basitonic or mesotonic to acrotonic, (1–)10–50(–90)-flowered; rachis (0–)2–25(–45) cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 3.5–12 mm long, longer at base of inflorescence than at tip, moderately to densely hairy. *Tepals* acute to acuminate, bright yellow, moderately to densely hairy on outside, glabrous on inside except for marginal rows of hair-like papillae on proximal 1/2; lateral flaps absent; dorsal tepal ± narrow-oblong to ± oblanceolate, truncate at base, not constricted below anther, 9–14 mm long, 1.5–2.3 mm wide; lateral tepals prominently asymmetrical; ventral tepal deeply saccate below anther. *Filaments* adnate to tepals; dorsal filament 4–5 mm long, 1/3–1/2 as long as dorsal tepal. *Anthers* bright yellow with white tips, introrse, held close together from their bases to tips of appendages, ± straight, adnate to tepals for lower 1/10–1/2 of loculi, all fertile; connective slightly narrower than to slightly wider than loculi; loculi minutely ciliate, 3–5 mm long; appendage ± oblong to ± triangular, 1.2–2.2 mm long, mostly 3/5–1/3 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 5–7 mm long, glabrous;

ovary slightly contracted at base, slightly thicker or no thicker than base of style; style curved ± smoothly or sometimes bent ± abruptly at base, not ridged, usually slightly thickened towards tip; abscission zone basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid to obovoid, smooth; long axis in line with stipe, slightly oblique to style; pyrene obovoid and sometimes slightly compressed, 8–11 mm long, 4.5–6 mm wide, smooth; seeds 1 or rarely 2; embryo straight; cotyledons not known.

Habitat: In white or grey sand or in gravelly soil, in forest or woodland dominated by *Eucalyptus marginata* and/or *E. calophylla* or less frequently in *Banksia* woodland or forest; often locally common.

Flowering period: July to January.

Distribution: (Fig. 34a) Darling district: from Lake Pinjar south to Blackwood River.

Conservation status: Not rare.

Variation: In *P. saccata* a morphocline runs from north to south. The extreme northern populations (Wanneroo – Lake Pinjar area) have leathery, subterete leaves which are grooved underneath and relatively small flowers (dorsal tepal 9–10 mm long). The extreme southern populations (Yallingup – Yalgorup area) have soft, dorsiventrally compressed leaves and large flowers (dorsal tepal 12–14 mm long). In the intervening areas these extremes are linked by a cline of intermediates. Striking differences in inflorescence morphology (rachis length, number of flowers) exist between specimens but these differences seem to be related to the time elapsed since the last fire. After a fire, plants regenerate vigorously and produce large inflorescences the following summer. The size of new shoots decreases each year thereafter until the plant becomes 'senescent' and no flowers and only short vegetative shoots are produced.

Discussion: This species may be distinguished by the following combination of characters: leaves linear, (1–)5–17 cm long, 0.8–1.4 mm wide; flowers irregular;

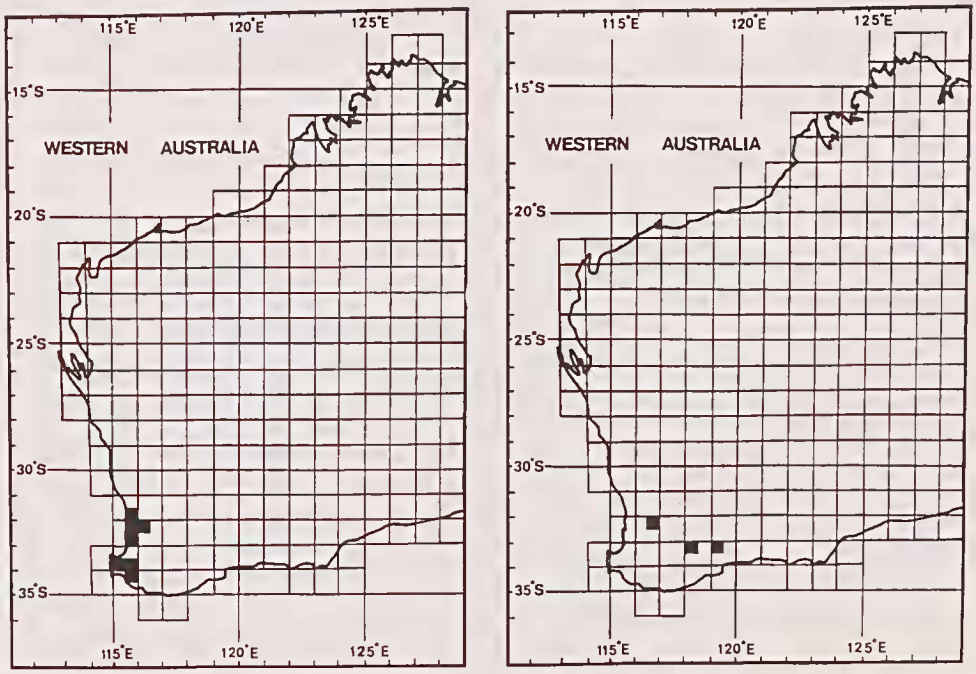

Figure 34. Distributions of **a**, *Persoonia saccata* and **b**, *Persoonia hakeiformis*.

tepals moderately to densely hairy on the outside; ventral tepal deeply saccate; anthers yellow with white tips; hypogynous glands 4, equal. It most closely resembles *P. comata* from which it is distinguished by the abovementioned leaf characters.

Selected specimens (46 examined): Darling: Pinjar road 3.8 km NNE of Wanneroo–Yanchep road, 31° 41' S, 115° 48' E, *P.H. Weston 263*, Dec 1980 (SYD, PERTH); Lake Banganup area near Jandakot, *B.R. Maslin s.n.*, 1971 (PERTH); Yalgorup National Park, 32° 53' S, 115° 48' E, *P.H. Weston 189*, Nov 1980 (SYD); Carbunup River crossing on road from Busselton to Margaret River, 33° 43' S, 115° 10' E, *B. Barnsley 817*, Jan 1979 (CBG); Queenwood, *M. Koch 2129*, Jan 1911 (NSW); Sues Bridge, Blackwood River, 34° 06' S, 115° 34' E, *R. Pullen 9914*, Dec 1974 (CANB).

42. Persoonia hakeiformis *Meisn.*

[Meisner (1852: 185) nom. nud.] (Meisner 1856: 330); Bentham (1870: 383).

Linkia hakeiformis (Meisn.) Kuntze (Kuntze 1891: 579).

Type citation: 'In colonia Swan River (Drumm. coll. 4, n. 275!) ... (v.s. in herb. Shuttl.)'

Syntypes: BM, CGE, FI, G (n.v., photo NSW), G-DC (n.v., photo NSW), K (2 sheets), MEL, NSW, NY, TCD.

Erect, spreading to decumbent shrub, usually with several to many stems branching from or near base, 0.3–1.8 m high; means of regeneration, underground parts not known. *Bark* smooth but flaky towards base, compact, mottled grey. *Hairs* of medium length, appressed to patent, greyish. *Branchlets* slightly angular when immature but becoming terete when mature, moderately to densely hairy when young but glabrescent after 2 or 3 years. *Leaves* alternate, linear, symmetrical, not twisted, subterete and grooved underneath, acuminate, not pungent, (0.5–)1.5–5 cm long, 0.8–1.4 mm wide, leathery and rigid, often crowded, mostly patent to suberect, usually curved upwards slightly to prominently or curved downwards slightly to prominently at tip, not glaucous, concolorous, sparsely to moderately hairy when immature, glabrescent when mature; venation hyphodromous; marginal veins absent; epidermis smooth to papillose and scaberulous. *Scale leaves* triangular to narrow-triangular, acute, 1.4–4.5 mm long, 0.6–1.2 mm wide. *Inflorescences* mostly terminal or subterminal, auxotelic or very rarely anauxotelic, basitonic, 1–60-flowered; rachis to 10 cm long. *Flowers* subtended by scale leaves or reduced leaves or leaves, irregular, mostly held ± horizontally. *Pedicels* 3–7 mm long, longer at base of inflorescence than at tip, densely hairy. *Tepals* acute or acuminate or obtuse or mucronate, bright yellow, glabrous on outside, glabrous on inside except for marginal rows of hair-like papillae which are restricted to proximal 1/2 of dorsal and lateral tepals but which extend almost to tip of ventral tepal; lateral flaps absent; dorsal tepal ± oblanceolate to ± narrow-oblong, truncate at base, not constricted below anther, 8–12 mm long, 2.3–2.7 mm wide; lateral tepals prominently asymmetrical; ventral tepal deeply saccate below anther. *Filaments* adnate to tepals; dorsal filament 3–4 mm long, 1/3–2/5 as long as dorsal tepal. *Anthers* bright yellow, introrse, held close together from their bases to tips of appendages, ± straight; dorsal and lateral anthers adnate to tepals to lower 1/5 of loculi, fertile; ventral anther adnate to ventral tepal, fertile or infertile; connective thick and wider than loculi; loculi of dorsal and lateral anthers glabrous, 3–4 mm long; appendages of dorsal and lateral anthers ± oblong to ± triangular, 0.7–2 mm long, 1/5–1/2 as long as loculi. *Gynoecium* about half length of stamens, hooked so that tip sits in pouch of ventral tepal below ventral anther, 4.5–6 mm long, glabrous; ovary slightly contracted at base, slightly thicker or no thicker than base of style; style curved ± smoothly or bent ± abruptly at base, not ridged, distinctly thickened towards tip; abscission zone

basal; ovules 2. *Hypogynous glands* 4, equal. *Drupe* ellipsoid, smooth; long axis in line with stipe, slightly oblique to style; pyrene obovoid, 8–13 mm long, 5–6 mm wide, smooth; seed 1; embryo straight; cotyledons 7–8.

Habitat: In sandy loam over laterite, in heath or mallee-heath to *Eucalyptus* woodland; very localised but locally common.

Flowering period: November to January.

Distribution: (Fig. 34b) South-western Australia: Boyagin Nature Reserve, Tarin Rock and Newdegate.

Conservation status: 3VCi (Briggs & Leigh 1988).

Variation: This species is poorly sampled but there does seem to be some between-population variation in leaf morphology, flower size and inflorescence morphology. The leaves of the Boyagin collections are mostly curved downwards at the tip whereas those of the Newdegate collection are curved upwards. The Newdegate collection has larger flowers (dorsal tepal 10–12 mm long) and inflorescences with shorter rachises (0–1.5 cm long) and fewer flowers (1–8) than do the Boyagin collections (dorsal tepal 8–9 mm long; inflorescence with (2–)8–60 flowers; rachis (0.1–)2–10 cm long). The only between-individual variation in the Boyagin population seems to be in the degree of curvature of the leaf tip. The Tarin Rock collection is ± intermediate in morphology between those from Boyagin and Newdegate.

Discussion: The ventral anther which is entirely adnate to the ventral tepal is diagnostic for this very distinctive and beautiful species. It may be recognised more easily by the combination of subterete leaves which are grooved underneath (i.e., revolute), irregular flowers with yellow anthers, deeply saccate ventral tepal, and tepals which are glabrous on the outside.

Specimens examined: Avon: Boyagin Rock Reserve, *H. Demarz 1302*, Jun 1969 (KPBG); Boyagin Nature Reserve, 32° 28' E 116° 53' E, *A.S. George 9816*, Jan 1970 (PERTH, SYD); 1 km NW of Boyagin Rock, 32° 28' S, 116° 54' E, *P.H. Weston 259*, Dec 1980 (SYD). Roe: Tarin Rock 1/2 mile W of siding along railway line, *J.W. Wrigley s.n.*, Nov 1968 (CBG); Newdegate, *W.E. Blackall 1296*, Nov 1931 (PERTH 2 sheets).

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New names and combinations are printed in **bold**, synonyms are printed in *italics*.